

FIFTY-FIRST ANNUAL REPORT
OF THE
NORTH CAROLINA
AGRICULTURAL EXPERIMENT
STATION

R. Y. WINTERS, *Director*

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DEPARTMENT
THE NORTH CAROLINA STATE COLLEGE
OF AGRICULTURE AND ENGINEERING
AND
STATE DEPARTMENT OF AGRICULTURE,
COOPERATING

STATE COLLEGE STATION
RALEIGH



FOR THE
FISCAL YEAR ENDED, JUNE 30, 1928
STATISTICAL SUMMARY FOR YEAR ENDING,
DECEMBER 1, 1928

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DECEMBER 1, 1928

LETTERS OF SUBMITTAL

STATE COLLEGE STATION,
RALEIGH, N. C.

PRESIDENT E. C. BROOKS,
*North Carolina State College of Agriculture and Engineering,
State College Station, Raleigh, N. C.*

DEAR SIR:

I have the honor to submit herewith the annual report of progress in agricultural research of the Agricultural Experiment Station of the North Carolina State College of Agriculture and Engineering and the North Carolina State Department of Agriculture. The report contains recommendations for strengthening research and a summary of results accomplished at the Central and Branch Stations during the fiscal year ending June 30, 1928.

Respectfully yours,

R. Y. WINTERS, *Director.*

COPY.

RALEIGH, N. C.

HONORABLE O. MAX GARDNER,
Raleigh, North Carolina.

MY DEAR GOVERNOR:

I take pleasure in transmitting to you the Fifty-first Annual Report of the North Carolina Agricultural Experiment Station. The report records the accomplishments of agricultural research for the year ending June 30, 1928.

The work of the past year has been conducted in accordance with the program approved by the Experiment Station Committee.

Very sincerely yours,

(Signed) E. C. BROOKS, *President.*

EXPERIMENT STATION COMMITTEE

(Appointed by Board of Trustees of College)

B. F. Shelton, Speed, N. C.
Clarence Poe, Raleigh, N. C.
David M. Buck, Bald Mountain, N. C.

(Appointed by State Board of Agriculture)

W. A. Brown, Rocky Point, N. C.
R. W. Scott, Haw River, N. C.
E. G. Roberson, Leicester, N. C.

JOINT COMMITTEE ON AGRICULTURAL WORK

(Appointed by Board of Trustees of College)

Robert N. Page, Southern Pines, N. C.
W. D. Laroque, Kinston, N. C.
J. F. Diggs, Rockingham, N. C.
Charles W. Gold, Greensboro, N. C.

(Appointed by State Board of Agriculture)

Clarence Poe, Raleigh, N. C.
O. Max Gardner, Shelby, N. C.
J. Vance McGougan, Fayetteville, N. C.
R. W. Scott, Haw River, N. C.

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OFFICERS AND STAFF
OF THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
JANUARY 1, 1929

| | |
|----------------|-----------------------------------|
| E. C. BROOKS | President of the College |
| I. O. SCHAUB | Dean of the School of Agriculture |
| R. Y. WINTERS | Director |
| C. B. WILLIAMS | Vice-Director |
| †F. E. MILLER | Director of Branch Stations |
| F. H. JETER | Agricultural Editor |
| A. F. BOWEN | Treasurer |

AGRONOMY

| | |
|----------------|---|
| J. J. MORGAN | Assistant in Soil Survey |
| †F. O. BARTEL | Drainage Engineer, in Coöperation with U. S. Department of Agriculture |
| A. S. CLINE | Assistant in Soil Fertility Investigations |
| W. A. DAVIS | Assistant in Soil Survey |
| R. B. DEVEREUX | Assistant in Soil Survey in Coöperation with U. S. Department of Agriculture |
| G. M. GARREN | Assistant in Plant Breeding |
| R. C. JOURNEY | Assistant in Soil Survey, in Coöperation with U. S. Department of Agriculture |
| P. H. KIME | Assistant in Plant Breeding |
| H. B. MANN | Assistant in Soil Fertility Investigations |
| E. G. MOSS | In charge Tobacco Investigations for the State Department of Agriculture and U. S. Department of Agriculture |
| C. B. WILLIAMS | Agronomist |
| L. G. WILLIS | Soil Chemist |
| R. Y. WINTERS | Plant Breeder |
| J. H. MOORE | Cotton Technologist |

ANIMAL INDUSTRY

| | |
|-----------------|-------------------------------|
| C. D. GRINNELLS | Dairy Investigator |
| J. O. HALVERSON | In charge Animal Nutrition |
| E. H. HOSTETLER | Swine Investigator |
| R. H. RUFFNER | Head, Animal Industry |
| F. H. SMITH | Assistant in Animal Nutrition |
| F. W. SHERWOOD | Associate in Animal Nutrition |

AGRICULTURAL ECONOMICS

| | |
|----------------|-----------------------------|
| R. C. CAMPBELL | Cotton Marketing Specialist |
| G. W. FORSTER | Economist |
| *R. J. SAVILLE | Assistant in Economics |

BOTANY

| | |
|--------------|-----------------------------|
| S. G. LEHMAN | Plant Pathologist |
| R. F. POOLE | Assistant Plant Pathologist |
| B. W. WELLS | Botanist |

HORTICULTURE

| | | |
|----------------|-------|---------------------------------|
| J. H. BEAUMONT | ----- | <i>Horticulturist</i> |
| M. E. GARDNER | ----- | <i>Assistant Horticulturist</i> |
| ROBERT SCHMIDT | ----- | <i>Assistant Horticulturist</i> |
| C. F. WILLIAMS | ----- | <i>Assistant Horticulturist</i> |

POULTRY HUSBANDRY

| | | |
|-----------------|-------|---|
| W. G. CROWDER | ----- | <i>Poultryman</i> |
| R. S. DEARSTYNE | ----- | <i>Associate Investigator and Pathologist</i> |
| B. F. KAUPP | ----- | <i>Poultry Investigator and Pathologist</i> |

RURAL SOCIOLOGY

| | | |
|------------------|-------|------------------------------|
| *W. A. ANDERSON | ----- | <i>Sociologist</i> |
| F. G. HAMRICK | ----- | <i>Assistant Sociologist</i> |
| R. I. SCHUMACHER | ----- | <i>Assistant Sociologist</i> |
| C. C. TAYLOR | ----- | <i>Sociologist</i> |

ZOOLOGY AND ENTOMOLOGY

| | | |
|---------------|-------|-------------------------------|
| B. B. FULTON | ----- | <i>Associate Entomologist</i> |
| Z. P. METCALF | ----- | <i>Entomologist</i> |

CENTRAL STATION

| | | |
|--------------|-------|------------------------------------|
| R. J. HARRIS | ----- | <i>Foreman</i> |
| F. E. MILLER | ----- | <i>Director of Branch Stations</i> |

†BRANCH STATIONS

Blackland Test Farm

| | | |
|----------------|-------|-------------------------------------|
| J. L. REA, JR. | ----- | <i>Assistant Director in Charge</i> |
|----------------|-------|-------------------------------------|

Coastal Plain Test Farm

| | | |
|---------------|-------|-------------------------------------|
| CHAS. DEARING | ----- | <i>Assistant Director in Charge</i> |
|---------------|-------|-------------------------------------|

Mountain Test Farm

| | | |
|-------------|-------|-------------------------------------|
| S. C. CLAPP | ----- | <i>Assistant Director in Charge</i> |
|-------------|-------|-------------------------------------|

Piedmont Test Farm

| | | |
|---------------|-------|-------------------------------------|
| F. T. MEACHAM | ----- | <i>Assistant Director in Charge</i> |
|---------------|-------|-------------------------------------|

Tobacco Test Farm

| | | |
|------------|-------|-------------------------------------|
| E. G. MOSS | ----- | <i>Assistant Director in Charge</i> |
|------------|-------|-------------------------------------|

Upper Coastal Plain Test Farm

| | | |
|-------------------|-------|-------------------------------------|
| R. E. CURRIN, JR. | ----- | <i>Assistant Director in Charge</i> |
|-------------------|-------|-------------------------------------|

*On Leave.

†Workers and Branch Stations under authority of the State Department of Agriculture, co-operating with the Agricultural Experiment Station in research.

FIFTY-FIRST ANNUAL REPORT
OF THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
FOR THE
FISCAL YEAR ENDING JUNE 30, 1928

By R. Y. WINTERS, *Director*

INTRODUCTION

The North Carolina Experiment Station celebrated its fiftieth anniversary on April 19, 1928. Appropriate tribute was paid on this occasion to the memory of its founders, to its contribution in research to the agriculture of our State, and to those workers who have led its activities in the past. Considerable time has been spent collecting information about the founders and the circumstances under which the Station was established so that a more complete history may be recorded. This material and the proceedings of the anniversary exercises will be published when printing funds are available.

RESEARCH IN RELATION TO PRESENT FARM NEEDS

Organized agricultural research was established in the State as a farm relief measure in 1877. It came at a time when the farmers of the State were very much in need of relief. A review of the activities of the Station leaves no doubt that it was an effective means of relief. Two things contributed largely to its early success—the high type of men who secured important facts, and the existence of organized farmers who were ready to receive them. The present unfavorable economic conditions of agriculture in our State is a problem requiring relief. Research and legislation have been suggested as remedies. No doubt both of these factors will have an important part, but intelligent legislation should be based upon facts secured by research. The recent coöperation of the Station with the State Tax Commission in the study of farm taxation in relation to income is a good illustration of the service research can render State legislation.

The extent to which research may analyze the causes of present economic conditions in the agriculture of our State will depend upon the development of outstanding specialists and the projection of research more fundamental to agriculture. The efficiency with which these facts may be applied will depend upon the extent to which the farmers of our State are organized for group action.

The development of outstanding specialists cannot be accomplished so long as individual workers must cover a broad field of inquiry. The large number of problems that have come from farmers and farmers' organizations in recent years have had a tendency to broaden the activities of the small number of research workers rather than encourage specialization. The economic

conditions have made farmers more keenly aware of smaller sources of loss and have prompted a larger number of requests for specific service from the research staff.

PERSONAL SERVICE TO FARMERS

During the past year the research staff has given direct service to more than 20,000 farmers of the State through correspondence and conferences. The following is a list of some of these services:

Examination of 2,304 specimens of diseased poultry and recommended treatments.
Examination of more than 800 samples of soil and supplying information regarding their treatment for more profitable crop production.
Supplying information on better practices of crop culture, improved varieties of crops, and reliable sources of seed.
Identification of several hundred specimens of diseased truck and field crops, with recommended remedies.
Identification of insect pests and suggested means of control.
Recommendations regarding livestock feeding, breeding and disease control.
Information on truck and fruit crop varieties, pruning culture, and fertilization.

In addition to requests that may be satisfactorily answered by letter or conference, there are others that cannot be adequately answered because of the lack of information in this or other research institutions. Such problems constitute subjects for further research. At the present time fifteen of such requests are on file awaiting maturity of important projects already under way or increased facilities for the expansion of research.

COOPERATION

The present program of research would be impossible were it not for the coöperation of the State Department of Agriculture, the United States Department of Agriculture, other State Experiment Stations, and commercial organizations. The State Department of Agriculture is maintaining the branch stations and a portion of the research conducted on them. Forty-six coöperative projects are conducted with six bureaus of the Federal Department of Agriculture. The nature of these coöperative studies are suggested by the following subject groups:

Classification and mapping of soil types by counties.
Fertilizer requirements of crops by soil types.
Studies with new sources of nitrogen and fertilizers high in plant food.
Testing pure bred dairy sires.
Testing new varieties of small fruits.
Quality of meat as influenced by feeding and breeding.
Soil erosion studies.
Studies of cotton grades and staple in relation to production and consumption.
Farm taxation in relation to farm income.
Cotton quality studies in relation to cotton spinning and seed improvement.
Tobacco fertilization, culture and breeding studies.
Forage crop studies.
Studies of cotton prices in relation to grades and staple.

The cost of these projects is borne half by the State and half by the coöperating bureaus of the U. S. Department of Agriculture. The future develop-

ment of this work will depend upon the facilities of the Station to supply its half of the work in research personnel and funds.

Coöperation with other State stations has consisted of group meetings of research workers in similar fields for the discussion of mutual problems and the formulation of uniform methods of attack. These meetings are usually held at one of the experiment stations of the South and at a time when the research in progress may be observed. In some cases assignments of different phases of the problems to workers has been made in order to broaden the attack and prevent duplication of work. The workers in the Departments of Animal Industry, Agronomy, Horticulture and Botany (plant disease section), have been most active in this type of coöperation. This is a form of coöperation that should be encouraged and further developed. Other research departments will undoubtedly find it helpful.

Twenty-two research projects are being conducted by members of the teaching staff in addition to the regular teaching work. Nineteen of these projects represent new lines of research in the College, while three supplement major research problems already under way. This work, therefore, broadens the research of the College and strengthens the attack on projects already under way.

Four projects are conducted in coöperation with commercial organizations. The projects originate in the Experiment Station but are partially supported by commercial organizations. Three of these projects are partially supported through research fellowships, and one consists of a direct grant to the project. The following is a list of these projects:

- National Fertilizer Association Fellowship for the study of strawberry fertilization.
- Agricultural and Scientific Bureau of the N. V. Potash Export My. Fellowship for the study of potash.
- Synthetic Nitrogen Products Corporation Fellowship for the study of concentrated complete fertilizer in relation to its effect upon cotton seedlings grown on sandy soils.
- Synthetic Nitrogen Products Corporation pasture fertilization studies with special reference to time and rate of applying nitrogen.

THE RESEARCH PROGRAM

Theoretically the agricultural research program of the State should parallel the agricultural problems with due consideration of their importance. If, however, narrow facilities are stretched over a broad field, the coverage is likely to be very thin and the research ineffective. The revision of the present program with relation to the outstanding problems will undoubtedly strengthen future work. Each project of the research program is carefully reviewed each year with relation to its accomplishments and future course, but this does not necessarily adjust the whole program in relation to the more important problems. A more complete study of such relations is now being made by the research staff.

An efficient program of research is dependent upon an efficient personnel and research facilities, such as land, laboratories, storage and equipment. The present program, or a revised program, will be handicapped by lack of facilities for work. In order that these may be considered along with the program, a list of the most urgent needs are given.

STATION NEEDS

1. Less than ten acres of the one hundred and fifty acres of the Station farm are suited to field plot experiments because of the irregular soil and contour. The following areas are needed for the completion of projects now under way :

| | |
|----------------------|----------|
| Agronomy ----- | 25 acres |
| Horticulture ----- | 25 acres |
| Plant Diseases ----- | 10 acres |
2. The present laboratory for soils research is inadequate for this purpose, and is now shared with advanced students in soils.
3. The demands from county agents and farmers for testing of unproductive soils and requests for special investigations have taken too much of the time of Mr. Willis to properly execute his assigned research. He should be given an assistant in soil chemistry to take care of these and other duties.
4. The field crop research is in need of storage and laboratory facilities. The seed storage and laboratory is now in the basement of Ricks Hall, where the equipment and seed are exposed to excessive moisture, and sometimes flooded. The cotton fiber studies are being done in an office 8 x 10 in size. The room is too small for laboratory work and does not provide storage for valuable apparatus and materials.
5. During the years of 1915 to 1927 the Station received through legislative appropriation approximately \$2,000 annually for printing. This included \$1,250 for printing bulletins plus the cost of printing the annual report. Although submitted in the College budget, this fund has not been available since 1927. The loss of this fund has materially crippled the distribution of information gained by research. The bulletin issues are now too small to supply the demands of county agents, vocational teachers, their students, and farmers.
6. The swine research is isolated on a small farm four miles from the College, detached from other livestock investigations and farm operations. This increases the overhead expenses of this research and prohibits swine studies in relation to other farm enterprises. A consolidation of this work with the beef cattle and sheep work would reduce the labor and overhead charges to these projects.

GREENHOUSES AND OTHER BUILDINGS

The work in soils of the Department of Agronomy and the plant disease research of the Department of Botany have been considerably strengthened by the addition of two greenhouses 22 x 30 feet in size. These greenhouses have made possible the execution of research under more controlled conditions and have extended the period over which crops can be grown. Additions were also made to the horticultural greenhouse system and head house which gave approximately 2,800 square feet additional greenhouse space, storage and laboratory room for research purposes.

The Department of Poultry was equipped with an isolated field plant for poultry disease studies at a cost of approximately \$1,500. The plant is built in units, with provision for future expansion of the disease work. The plant is now being used for the study of soil pollution and other means of transmitting the white diarrhea disease of poultry.

CHANGES IN THE STAFF

The following changes have taken place in the Station staff during the past fiscal year: Mr. M. E. Gardner, formerly of Virginia, was appointed assistant in horticulture, to succeed Mr. W. A. Radspinner. Mr. Gardner's appointment

took effect November 1, when he took active charge of fruit investigations at the Piedmont and Mountain Branch Stations.

Mr. R. S. Curtis, in charge of beef cattle and sheep investigations, resigned January 1, and was succeeded by Mr. Earl H. Hostetler, formerly in charge of swine investigations at this station. The change will consolidate the research in beef cattle, sheep and swine.

Mr. J. E. Foster, a graduate of this institution, with post graduate work at the University of Kansas, was appointed assistant in beef cattle and sheep investigations January 1.

Dr. B. B. Fulton, formerly of the Iowa Experiment Station, was appointed associate in entomology May 1.

Mr. D. L. Wray was given a temporary assignment in the Department of Entomology, beginning May 1. His work was concerned with special investigations of the corn ear and root worms.

Dr. J. H. Beaumont, formerly of the Minnesota Experiment Station, was appointed to succeed Mr. C. D. Matthews, who resigned April 1. Dr. Beaumont began work July 1.

PUBLICATIONS

One technical bulletin and four bulletins of the regular series were published during the past year. Because of lack of printing funds it was necessary to carry over manuscript for eight additional bulletins. The Department of Agronomy prepared and distributed sixteen mimeographed information circulars. Three technical papers were prepared and submitted to scientific journals. The following is a list of these publications:

Technical Bulletin No. 30. The Toxicity to Cotton Seedlings of High Concentrations of Soluble Nitrogenous Fertilizers.

Bulletin No. 253. Methods and Cost of Raising Lambs to Marketable Age.

No. 254. I. The Cost of Producing Eggs with S. C. White Leghorns; and II. The Control of Roup and Its Effect Upon Egg Production.

No. 255. Influence of Crop Rotation and Soil Treatments Upon the Yield of Crops on Norfolk Sandy Loam Soil.

No. 256. Influence of Crop Rotation and Soil Treatments Upon the Yield of Crops on Cecil Clay Loam Soil.

INFORMATION CIRCULARS FROM THE DEPARTMENT OF AGRONOMY

1. Your Soils May be Examined Without Cost. (Out of print.)
2. Fertilizers Recommended for Important Crops in North Carolina Based Upon Field Experiments.
3. Facts About Improved Cotton Seed for North Carolina Based Upon Field Experiments.
4. Soil Acidity and Lime for North Carolina Soils.
5. Standard Varieties of Corn for the Mountains, Piedmont and Coastal Plain Sections of North Carolina.
6. Summary of Variety Tests of Soybeans and Recommendations for North Carolina.
7. Use of Commercial Fertilizers by North Carolina Farmers.
8. Crops and Their Highest Yielding Varieties and Strains for Different Sections of North Carolina.
9. Identification of North Carolina Soil Types.
10. Results of Cotton Spacing with Recommendations.
11. Results of Soil Building Demonstrations in North Carolina.

12. Methods of Mixing and Using Concrete on the Farm.
13. Farm Home Water Supply System: I. Inexpensive Kitchen Installation.
14. Farm Home Water Systems: II. Kitchen and Bathroom Installations.
15. A Septic Tank for the Farm.
16. Agricultural Limestone and Marls of North Carolina.

DETAILED REPORTS

The results accomplished at the Central and Branch Stations for the year ending June 30, 1928, are given in some detail by the heads of departments in the following pages of this report. The financial statement of the Station is appended following the detailed reports.

R. Y. WINTERS, *Director.*

RESEARCH IN AGRICULTURAL ECONOMICS

The Department of Agricultural Administration has been conducting during the last five years research in farm organization and management in each of the four typical areas of the State:

1. Coastal Plain (Johnston, Harnett and Columbus counties).
2. Lower Coastal Plain (Craven County).
3. Mountain Area (Macon County).
4. Upper Coastal Plain (Northampton County).

The projects in the first two areas mentioned have been completed. A bulletin has been published entitled, "Profitable Farm Organizations for the Coastal Plain of North Carolina," Research Bulletin No. 1. A second bulletin has been published, Station Bulletin No. 252, entitled, "Profitable Farm Combinations." The subject-matter of this bulletin relates particularly to the condition in the Lower Coastal Plain as typified by the agriculture in Craven County.

The manuscript for the third bulletin has been completed and printed as Experiment Station Bulletin No. 260, entitled, "Systems of Livestock Farming for the Mountain Region of North Carolina." This bulletin deals with farm organizations and management in the Mountain Region. The subject-matter refers particularly to the agriculture in the southwestern part of the region, especially Macon and Jackson counties. The information, however, is also applicable to other counties having similar agricultural conditions.

A fourth bulletin is now in preparation dealing with the farm organization and management in Northampton County. The work in this county has been in progress for the past two years. In 1927 the work was detailed and exhaustive in nature and limited to approximately thirty farms. This year, 1928, the work has been more general in character and approximately sixty-five farms have been included in the investigation. In 1929 the work will be extended with the general objective of helping the farmers reorganize their farms in accordance with the research work done in 1927-28. The results obtained from this new work will reveal to what extent farmers can reorganize their farms profitably.

Agricultural Credit Problems in North Carolina. This project, as outlined in the report last year, was conducted in coöperation with the U. S. Department of Agriculture for the purpose of obtaining information on credit conditions in North Carolina, with special reference to the cost of credit. The field work was completed last year. Progress has been made in the preparation of the report. The bulletin is being prepared by Mr. David L. Wickens, of the U. S. Department of Agriculture, in coöperation with the Head of the Department of Agricultural Economics, North Carolina State College of Agriculture and Engineering.

Farm Taxation. The work in taxation, conducted in cooperation with the U. S. Department and the State Tax Commission, is practically completed. The field work was completed February, 1928, and the report has been finished.

It will probably be published before the first of January. This report covers three important phases of agricultural taxation; namely, (1) the per cent of the net income of farmers absorbed by taxes; (2) the per cent of the returns to farm property or net returns absorbed by taxes; and (3) the assessment and equalization of farm property for taxation purposes. The report, as written, consists of eight chapters.

Cost of Producing Farm Products in North Carolina. Little work has been done so far on this project because of the time devoted to other projects which must be finished. Beginning January 1, 1929, it is planned to start the analysis of the data which has already been assembled.

Farm Income in North Carolina. The field work on this project has been done in connection with the tax study. It is proposed to publish one general bulletin on the farm income and one bulletin for each of the different areas of the State, giving detailed information regarding the factors affecting income.

Cotton Marketing. This project was initiated for the purpose of determining the relationship between the grade and staple of cotton and price received by the farmer. Representative gins throughout the cotton area of the State are cooperating with the Department. Each gin is taking samples from each bale ginned. These samples are forwarded to the United States Department of Agriculture's classing laboratories for the determination of grade and staple. On each bale is placed a tag having a duplicate serial number to that on the ticket placed in the sample taken from the bale. Buyers at certain designated points throughout the State are cooperating. From these buyers the price, date of sale, and miscellaneous information is secured relative to the bales. In this manner it is possible to correlate the grade and staple with the price received.

Strawberry Study. The field work on this project has been completed and a large part of the tabulation work has already been done. Most of the tabulation was done by this department. However, the U. S. Department of Agriculture is completing the tabulation and the material will be ready for analysis by the first of January, 1929.

Technical Papers Published. The Department has not published any technical articles other than those which appeared in the report of the Social Science Research Council dealing with the research work in agricultural economics. These papers included a summary of the research work and also an article on commodity studies. In connection with the work of the Social Science Research Council, the Department supplied a section of the handbook on Agricultural Economic Research. The section written applied directly to administration as it affects research in the field of agricultural economics.

G. W. FORSTER,

Head, Department of Agricultural Economics.

RESEARCH IN AGRONOMY

During the year the research of this department has been continued along the lines of soil chemistry, soil fertility, crop rotation, plant breeding, crop improvement, cultural treatment, and other problems bearing upon the economic production of crops in North Carolina. Considerable work has been done on the classification and mapping of soils of the State, the county being the unit area for this work.

The work in the field of soil chemistry has been concerned with studies of the magnesium and manganese deficiency of certain important soil types. These elements have been studied in relation to dolomitic lime and calcite applications, and the soybean has been used as an indicator of their deficiency. Some attention has also been given to the study of peach winter-killing with the purpose of finding the causes of this trouble in the sandhill section of Moore County.

Soil fertility experiments are being continued on a number of important soil types, on the Central Station, and at six of the branch station farms. These investigations are designed to study the main plant food deficiencies of each type of soil occurring in the State and to work out the best kinds and amounts of fertilizers to use for the most important crops. Considerable attention is also being devoted to a study of the value of different methods and dates of applying fertilizers, particularly nitrogen. Since the coming into more general use of concentrated fertilizer mixtures and the wider use of cheaper inorganic sources of nitrogen in them, these studies have become imperative. The department wishes to be in a position to advise farmers as well as manufacturers intelligently regarding their value and the precautions that must be observed in using them.

For many years the department has been studying the relative value of different systems of crop rotation for various soils and under different soil treatments. As a result of these studies two bulletins have been prepared, one covering results for the Piedmont and the other for the Coastal Plain section.

The work of classification and mapping of soils conducted in coöperation with the Federal Bureau of Chemistry and Soils, has been continued actively during the year. The reports covering this work furnish exact information with reference to the location of different soil types by counties and their special crop adaptations. This information furnishes a basis for all field experiments which are being conducted by the department.

As a result of the work in crop improvement and a comparative study of the value of existing varieties and strains of leading crops, many new varieties and strains have been introduced and are being widely grown by farmers of the State.

The results from studies of different dates for planting cotton seed and the spacing of plants in the row have been rather definite and have led to the quite general adoption of the new methods by cotton growers.

SPECIAL FERTILIZER AND SOIL FERTILITY PROBLEMS

Magnesium Deficiency of Sandy Soil Types. A test of the effect of liming with pure crystalline dolomite and calcite on the growth of soybeans on Norfolk and Durham sandy loams has given evidence of the superiority of the former under experimental conditions that indicate the needs of the two soils for added magnesium.

With calcium, magnesium, nitrogen, phosphorous and potassium supplied, there is evidence that there may be other elements deficient in both these soils which may become limiting factors. With vegetation experiments in tile containers, the superiority of sulphate of potash over chloride of potash is interpreted as indicating that the sulphur supply is an important factor.

A limitation of the use of dolomitic limestone as a source of magnesium is indicated in these experiments by the fact that heavy liming was inferior to a lesser rate, while in the field, on another sandy soil type, two tons per acre of ground dolomitic limestone with normal fertilization caused injury to soybeans. This was corrected by the application of manganese sulphate as a fertilizer. Practical conclusions from these observations show that the use of dolomitic limestone on sandy soils for the purpose of supplying magnesium should be limited to rates that will not completely neutralize all the soil acidity.

Fairly reliable indications of specific soil deficiencies have been observed in controlled experiments with soybeans where three distinct types of chlorosis indicate cultural conditions that are remediable respectively by applications of fertilizers containing magnesium, manganese, or potassium.

Potassium was seriously deficient on the Norfolk soil, but there was no conclusive evidence in the growth of soybeans that added potassium liberated appreciable quantities of magnesium.

The abnormalities of soils exposed to normal rainfall in containers has been observed by other investigators. It appears from the results of this year's work that this may be advantageous to some extent for experimentation as it accelerates losses by leaching, thereby shortening the time required for soil deficiencies to be noted.

Analyses of leachings from lysimeters, having the same soils and treatments as had the cylinders on which soybeans were grown, have not been completed.

Muck Soil Problems. A series of experimental plats were started at the Blackland Branch Station for the purpose of studying some of the abnormalities.

Field tests with lime and superphosphate in other years have shown that heavy applications of these materials may be injurious and an attempt was made to determine the nature and cause of the injury. No visible symptoms developed during the year and the plat yields have not yet been determined.

A pot test of the effect of lime in varying amounts with and without copper and manganese salts on an unproductive muck soil showed that heavy liming is a prime requisite to the production of soybeans. No effect of added copper and manganese has been noted.

A preliminary survey was made of the principal peat and muck areas of the State with a representative of the United States Department of Agriculture.



The growth of soybeans with calcite and dolomite on Durham sandy loam. Rates of application were equivalent to one ton of pure calcium carbonate. Number 15 shows the growth where calcite was used and number 16 that where dolomite was used.

The work proposed involves a determination of the origin and structure of representative peat and muck types. Limitations in time and support of local agencies do not permit of formal coöperation in these investigations.

Strawberry Fertilizer Experiments. The results obtained under this project have indicated the necessity of a revision of the plan of treatments to provide more check plats and to reduce the total number of plats so that the picking can be facilitated. The results under the new plan will be comparable with those of the old.

The yields of the second year were in agreement with previous results indicating that liming is not advisable for strawberries on the soil of the experimental field.

The yields of the current year showed a distinct gain from the use of complete fertilizers with some evidence that the standard formula of 1,000 pounds of 7-5-5 might be increased in per cent of potash with benefit.

Unproductive spots have persisted in the field on which these plats were located as well as in numerous other strawberry fields on similar soils. The cause of this condition is not known and, though yields of the experimental plats were corrected for imperfect stands, this unfavorable soil condition may vitiate to some extent the results on some of the plats of the fertilizer tests.

Peach Winter-killing. Trees receiving late applications of nitrate of soda in addition to the normal spring fertilization have continued to appear more thrifty than the trees that did not have this application. The mortality record, however, does not show conclusively that this thriftiness is associated with immunity to winter-killing. The experiment, as originally planned, was to have included a test of cultural practices which have not been followed. Rapid progress cannot be made in this investigation until more profitable seasons justify the closer coöperation of orchard owners or until the Experiment Station can control an orchard.

Miscellaneous Technical Services. Numerous samples of limestones for use on soil have been analyzed for farmers and county agents, and many soils, especially from fields where crop yields are unsatisfactory, have been examined. Advice with reference to the latter has been followed with success in an encouraging number of instances, and it is felt that the value of the service justifies its continuance.

The addition of a greenhouse for pot culture experiments has facilitated the study of soil fertility problems along the lines of the accepted projects and in closely related fields.

RESULTS OF FIELD EXPERIMENTS SHOWING THE VALUE OF CROP ROTATION AND PLANT FOOD NEEDS

MOUNTAIN BRANCH STATION (Toxaway and Porter's Loam)

Soil Fertility Experiments. With Irish potatoes in these experiments on Toxaway loam, the following general observations are made for the year:

- (1) The use of lime alone and with 800 pounds of a complete fertilizer materially reduced the quality of the tubers produced by the encouragement of scab. This disease was very bad on all plats which received lime.

(2) Muriate of potash as the source of potash in a complete fertilizer gave a slightly better yield than did sulphate of potash and a marked increase over kainit.

(3) The application of 800 pounds per acre of complete fertilizer analyzing 8-4-6 almost tripled the yield of plats where no fertilizer was applied, and practically doubled that where only two plant food constituents were added. An increase from 400 to 800 pounds of a complete fertilizer resulted in an increase in yield of 29 bushels of potatoes per acre.

For wheat and soybeans grown in the rotation on this farm, muriate of potash and kainit, as sources of potash, produced larger yields than did the use of sulphate of potash. Lime and nitrogen each used alone were especially beneficial to the wheat crop. The use of lime for soybeans has proven indispensable for the largest and most profitable yields of hay.

Study of Relative Value of Different Sources of Phosphoric Acid. In this experiment on Toxaway loam, superphosphate, finely ground phosphate rock, soft phosphate and basic slag were compared as sources of phosphoric acid in a complete fertilizer when applied to wheat, red clover and corn grown in rotation. These comparisons were made on two series of plats, one series receiving lime, and another without lime. The results of ten years work with wheat have shown that superphosphate, basic slag, rock phosphate and soft phosphate rank in value in the order given when used on the limed plats. On the unlimed plats the rank has been basic slag first, then superphosphate, rock phosphate and soft phosphate. On the limed plats grown to corn, basic slag ranked first, followed by superphosphate, rock phosphate and soft phosphate. For unlimed plats grown to corn, the rank was basic slag, soft phosphate, superphosphate and rock phosphate.

Crop Rotation Studies. This experiment has been conducted on Porter's loam (upland) soil. Among other things in this experiment, a study is being made of continuous cropping of corn and wheat, each on the same land year after year in comparison with a two-year rotation of corn and wheat; with a two-year rotation of wheat, crimson clover and corn with soybeans planted in the crop for soil improvement; and with a three-year rotation of wheat, red clover and corn with soybeans in the corn for soil improvement.

All plats have received an application of 400 pounds of complete fertilizer and one-half of all plats a broadcast application of limestone every three years at the rate of 2,000 pounds per acre.

During the past five years corn grown in a simple rotation with wheat without lime has yielded an average of 7.5 bushels per acre more than when it was grown continuously on the same land. When a similar comparison was made on limed plats there was no difference in the average yield of corn. Continuous corn, when limed, yielded 13.6 bushels more per acre than it did without the use of limestone.

Continuous wheat, unlimed, yielded on an average 0.7 bushels less than it did when grown in a two-year rotation of wheat and corn. When limed, the yield of the wheat in the two-year rotation was greater by 1.1 bushels per acre than when grown continuously on the same land. Continuous wheat yielded 1.3 bushels more than was secured on an average when it was left unlimed while the wheat in a two-year rotation with corn yielded 1.7 bushels more when limed than when unlimed.

Other experiments have compared the yield of corn when grown continuously, when grown in rotation with wheat, and when inter-cropped with cowpeas followed by wheat and crimson clover. The following table contains the average yields per acre of corn when grown in these rotations with and without lime during the past five years:

| | <i>Limed</i> | <i>Unlimed</i> |
|---|--------------|----------------|
| Corn, continuously | 34.9 | 22.2 |
| Corn, with wheat alone..... | 34.9 | 27.4 |
| Corn, cowpeas, wheat, crimson clover..... | 47.0 | 35.6 |

The results show marked benefits following the applications of lime, and the importance of soil building leguminous crops in the two-year rotation.

The results with wheat in the above rotations and in a three-year rotation with red clover are as follows:

| | <i>Limed</i> | <i>Unlimed</i> |
|---|--------------|----------------|
| Wheat, continuously | 8.4 | 7.1 |
| Wheat, with corn alone..... | 9.5 | 7.8 |
| Wheat, crimson clover; corn, cowpeas..... | 18.2 | 8.2 |
| Wheat, red clover; corn, cowpeas..... | 27.3 | 15.4 |

These results bring out very strikingly the value of lime and suitable legumes in the rotation if the greatest production of wheat on upland soil in the mountains of the State is to be secured.

In the case of red clover in the three-year rotations, the use of limestone increased the yield of hay 175 per cent in 1924. With soybeans (sown broadcast in place of clover) in 1927, an increase of 34.5 per cent was secured.

AT PIEDMONT BRANCH STATION (Cecil Clay Loam)

Soil Fertility Work. This experimental work is being conducted for the purpose of determining the chief plant food deficiencies of this type of soil and finding the best proportions of fertilizing constituents for different crops adaptable to the Piedmont region. A four-year rotation is followed on the two fields devoted to these studies, one-half of each plat being limed every three years. The rotation is as follows:

| | |
|------------------|-----------------------|
| First year..... | Cotton, rye |
| Second year..... | Corn, wheat (in fall) |
| Third year..... | Wheat, red clover |
| Fourth year..... | Red clover |

Results, secured over a period of eighteen years, show that phosphoric acid is the main limiting plant-food constituent in the profitable production of corn, cotton, and wheat, with nitrogen ranking second in importance. Potash is the least required of the three constituents. Lime, phosphoric acid, and potash have been found determining factors in the successful growth of red clover. For the past eight years, this crop has been a complete failure on the unlimed portion of all plats, except those on receiving the heavier applications of phosphoric acid or potash. On the limed portion of the plats, phosphoric acid has given greater yields of red clover than has the two other plant-food constituents.

Superphosphate vs. Rock Phosphate. Results from field experiments continue to show superphosphate a more efficient carrier of phosphoric acid



Fertilizer rotation experiments with wheat at Piedmont Farm. Plot 6. The wheat was treated with 400 pounds of an 0-3-1½ mixture per acre and yielded 3.3 bushels per acre. Contrasting this yield with plot 8 shows the marked results following an application of phosphoric acid supplementing nitrogen and potash.



Plot 8 of the fertilizer rotation experiments with wheat on the Piedmont Farm. The wheat was treated with 400 pounds of a 7-3-1½ and yielded 20.5 bushels per acre.

than rock phosphate when each is used to supply normal amounts of phosphoric acid for corn, wheat and red clover.

Nitrogen Carriers. This experiment is designed to compare the relative value of nitrate of soda, sulphate of ammonia, nitrate of ammonia, calcium cyanamid, sludge, cottonseed meal, leunasalpeter, and urea, as carriers of nitrogen in a complete fertilizer for cotton and corn grown in rotation. Results with corn in 1927 show nitrate of ammonia and cottonseed meal best, followed by urea, nitrate of soda, leunasalpeter, sulphate of ammonia and calcium cyanamid in the order named. Sludge proved the poorest source of all.

Crop Rotation Experiment. The crop rotation work consists of a study of the value of one, two, and three-year rotation, with and without legumes (cowpeas, soybeans and red clover), the fertilizer application being the same for all rotations. Results with wheat in a two-year rotation of corn and wheat with a legume for soil improvement, show a gain of 11.5 per cent on the unlimed soil over the same rotation without a legume. On the limed soil the gain was 23 per cent. Results for the two-year rotation show an increase of 100 per cent on the unlimed soil over continuous cropping of wheat, and 81 per cent on limed soils. Past results with wheat show a gain for the three-year rotation of 63 per cent over continuous cropping on unlimed and 135 per cent on the limed soil.

AT CENTRAL EXPERIMENT STATION (Cecil Clay Loam)

Experiment on Top-dressing of Cotton and Corn. In this experiment results with corn in 1927 show no advantage in top-dressing on this type of soil. With cotton a gain of around 200 pounds of seed cotton per acre was made by top-dressing between June 1 and 22. Top-dressing to cotton made later than these dates showed no economic gains.

Study of Proportions of Organic to Inorganic Nitrogen. Three sources of inorganic nitrogen—nitrate of soda, sulphate of ammonia and leunasalpeter—were used in varying proportions with cottonseed meal as the organic source. Using nitrate of soda to supply 65 per cent of cottonseed meal 35 per cent of the total nitrogen in a complete mixture gave best results in 1927. Where sulphate of ammonia supplied 80 per cent and cottonseed meal 20 per cent, the yield was largest. When using leunasalpeter as the inorganic source of nitrogen, a ratio of 80 per cent from leunasalpeter and 20 per cent from cottonseed meal was the best proportioning of the inorganic and organic sources of nitrogen in a complete mixture.

Sources of Lime. In this experiment burnt lime, hydrated lime, and ground limestone are applied every four years at the equivalent rates of one, two, three and four tons of calcium carbonate per acre. Soybeans for seed, rye, corn, oats-and-vetch (for hay), soybeans (for seed), cotton, and crimson clover (for hay), are being grown in a four-year rotation, with soybean vines and rye used for soil improvement. All plats were fertilized with equal amounts of phosphoric acid from 16 per cent superphosphate, but no nitrogen or potash was added. Best yields with oats-and-vetch for hay were obtained from the unlimed plat and the plat limed with a two-ton equivalent of calcium carbonate in the form of burnt lime. With soybeans, the best yield was secured from the unlimed plat.

AT COASTAL PLAIN BRANCH STATION (Norfolk Fine Sandy Loam Soil)

Soil Fertility Experiment. In this experiment the nitrogen, phosphoric acid and potash were applied as nitrate of soda, super-phosphate and manure salt in varying amounts and ratios to determine the main plant requirements of this type of soil. The north half of all plats have received a broadcast application of one ton of ground dolomitic limestone every three years since 1917.

As in previous years, the yield of oat-and-vetch hay on the limed end of this field was less than on the unlimed end of the corresponding plats, which is shown by the following yields:

| Fertilizer per Acre | Ratio | Yield Hay per Acre— Unlimed— Pounds | Yield Hay per Acre— Limed— Pounds | Difference in Favor Unlimed— Pounds |
|---------------------|-------|--|--|--|
| No fert lizer | | 1900 | 1880 | 20 |
| 300 | 0-4-2 | 3680 | 1880 | 1800 |
| 300 | 6-0-2 | 3700 | 3480 | 220 |
| 300 | 6-4-0 | 3740 | 2980 | 760 |
| 300 | 6-4-2 | 5020 | 4800 | 222 |

Undoubtedly this difference in yield is partly due to the difference in composition of hay, that from the limed end of the field having a much larger per cent of vetch than from the corresponding unlimed end.

Corn and soybeans, the latter harvested simply for seed in the rotation on this field, unlike oats-and-vetch, have produced greater yields on the limed end of the field than on the unlimed. However, as previously reported, a larger percentage of the corn on the limed end has been broken over due to the decidedly greater per cent of plants affected with root rot.

All three crops in the rotation (corn, soybeans and oats-and-vetch) responded best to a complete fertilizer containing nitrogen, phosphoric acid and potash. Nitrogen and phosphoric acid were apparently most important for oats-and-vetch, while for soybeans a high per cent of potash is important. For corn, all three are very effective and therefore important to be supplied for best paying results.

Soil Type Experiment. In this experiment the same amount of nitrogen, phosphoric acid and potash are applied each year as are removed by the crops. These nutrients are supplied respectively from nitrate of soda, super-phosphate and manure salt in single, double and triple combinations. When applied singly for oats-and-vetch, phosphoric acid gave the largest increased yields. In double combinations, nitrogen and phosphoric acid were more profitable. When potash was added to this mixture making a complete fertilizer, a very marked increase in yield was obtained. The results show the necessity of a complete fertilizer. An average comparison for twelve years of superphosphate and basic slag as sources of phosphoric acid in a complete fertilizer shows very little difference in efficiency between these two carriers of phosphoric acid when used on this type of soil. During the course of these experiments four crops of corn, soybeans and oats-and-vetch have been grown.

AT UPPER COASTAL PLAIN BRANCH STATION (Norfolk Sandy
Loam and Okenee)

Concentrated vs. Low Analysis Fertilizers. As in previous years, results obtained with cotton on Norfolk sandy loam indicate that concentrated fertilizers, applied with proper precautions, are just as effective as the less concentrated mixtures made from superphosphate and manure salt, with the ammonia derived one-half each from cottonseed meal and nitrate of soda. The average yield from 400 pounds per acre of a 16-8-8 is slightly greater than from 800 pounds of an 8-4-4, while 400 pounds of an 18-6-6 has not given quite as large average returns as 800 pounds of a 9-3-3 mixture.

Sources of Nitrogen. The object of this experiment, located on Norfolk sandy loam soil, is to compare the relative efficiency of nitrate of soda, leunasalpeter, urea, sulphate of ammonia, calcium nitrate, cyanamid, fish scrap, and cottonseed meal as carriers of nitrogen when applied singly as the sole source of nitrogen and in combinations of different proportions in a complete fertilizer.

Similar to the previous year, the spring of 1927 was a very dry one during the early growth of the cotton crop. This resulted in considerable injury to the young plants from the use of large quantities of fertilizer applied in the drill before planting. This injury was more severe on those plats receiving all their nitrogen from inorganic sources. As the season progressed, however, the cotton treated with inorganic nitrogen overcame this temporary setback, and the final results show larger yields from the inorganic than from the organic sources of nitrogen used in the complete fertilizers.

General Fertilizer Experiment Rotation of Corn and Soybeans. Although this experiment, which is located on Okenee type of soil, was only started in 1926, some very marked differences have already been obtained in the yields of corn following the soybeans picked for seed (the stalks and leaves returned to the soil) as compared with the yields following soybeans grown and cut for hay. The resulting yields and differences in yield of corn following the two methods of harvesting are shown below for the different fertilizer treatments:

| Fertilizer Treatment, Pounds per Acre | Formula | Soybeans Picked, Bushels Corn per Acre | Soybeans Cut, Bushels Corn per Acre | Increase in Yield of Corn Due to Residue of Soy- beans Picked, Bushels Corn per Acre | Per cent Increase |
|--|---------|--|---|---|----------------------|
| 600..... | 6-0-0 | 32.8 | 21.3 | 11.5 | 54 |
| 600..... | 0-0-4 | 33.9 | 21.3 | 12.6 | 59 |
| 600..... | 6-6-0 | 49.7 | 31.0 | 18.7 | 60 |
| 600..... | 0-6-4 | 54.9 | 46.7 | 8.2 | 18 |
| 600..... | 6-0-4 | 27.7 | 26.2 | 1.5 | 6 |
| 600..... | 6-6-4 | 52.8 | 40.5 | 12.3 | 30 |
| 600..... | 6-6-4 | 44.1 | 41.5 | 2.6 | 6 |
| 2000 1 mestone | | | | | |
| 0..... | ---- | 26.9 | 19.2 | 7.7 | 40 |

The percentage increase in yield of corn following soybeans picked for seed over soybeans cut for hay varied from 6 to 60 per cent, the average percentage increase for all the fertilizer treatments being 34 per cent.

The results also indicate that, for corn grown on this type of soil, nitrogen is most essential in a complete fertilizer with potash and superphosphate ranking in the order named. Lime has not as yet proved beneficial.

The results as a whole indicate that soybean seedlings are very sensitive to heavy applications of fertilizer, especially those containing relatively high percentages of nitrogen and potash. On these plats it has been difficult to secure good stands of the soybeans.



Outlying field fertilizer experiment with cotton on Norfolk sand in Wayne County. The cotton in the center was unfertilized, while that on either side received 800 pounds per acre of a complete fertilizer.

Dates of Applying Nitrogen as a Top-dressing to Cotton. Before planting the cotton this year 800 pounds per acre of an 8-3-3 fertilizer was applied in the row to all plats. On June 1, 100 pounds of nitrate of soda was applied as a top-dressing along the rows in plat No. 1, and at three-week intervals thereafter the successive plats were top-dressed with the same amount of nitrate of soda per acre. The soil used for this experiment is of the Norfolk sandy loam type. The results are shown in the following tables:

| Plat | Nitrate of Soda Applied as a Top-dressing | | Yield Seed Cotton per Acre—Pounds |
|---------|---|--------------|-----------------------------------|
| | Pounds per Acre | Date Applied | |
| 1. | 100 | June 1 | 1920 |
| 2. | 100 | June 22 | 1830 |
| 3. | 100 | July 13 | 1830 |
| 4. | 100 | August 3 | 1730 |
| 5. | 100 | August 24 | 1650 |

The plats receiving an application of nitrate of soda from three to six weeks after planting have given decidedly the highest yields.

AT BLACKLAND BRANCH STATION (Muck)

Lime Experiment. This experiment was designed to determine the relative efficiency of hydrated lime, ground limestone and marl when used on the muck soil of this farm. The materials were applied at rates equivalent to 1, 2, 3 and 4 tons of calcium carbonate per acre every three years. Below is given the average yield of corn for ten years when treated with the various sources of lime:

| Tons Lime Applied per Acre Every Three Years | Limestone, Corn per Acre, Bushels | Hydrated Lime Corn per Acre, Bushels | Marl Corn per Acre, Bushels |
|---|---|--|-----------------------------------|
| Equivalent of 1 ton calcium carbonate | 28.1 | 23.5 | 19.4 |
| Equivalent of 2 tons calcium carbonate | 31.5 | 30.8 | 29.3 |
| Equivalent of 3 tons calcium carbonate | 32.3 | 29.7 | 29.2 |
| Equivalent of 4 tons calcium carbonate | 32.0 | 30.8 | 31.5 |

It appears from these results that ground limestone is the most efficient source of lime when all are applied at a rate equivalent to one ton of calcium carbonate per acre, hydrated lime and mark ranking next in the order named. With the 2, 3 and 4-ton equivalent applications, no great differences in yield resulted from the different treatments, although what differences did occur were in favor of the limestone.

The average results with corn for the ten years show that the addition of 300 pounds per acre of an 8-2-4 fertilizer with lime gave an increase in all cases. The yields were decreased, however, when the fertilizer was applied without lime as is shown by the results given in the table below:

| Fertilizer per Acre—Pounds | Calcium Carbonate per Acre— Tons | Corn— Bushels | Increase Due to Fertilizer— Bushels | Increase Due to Limestone— Bushels |
|----------------------------|---|------------------|---|--|
| No fertilizer | None | 14.0 | --- | --- |
| 300 pounds 8-2-4 | None | 11.5 | 2.5 | --- |
| No fertilizer | 1 | 28.1 | --- | 14.5 |
| 300 pounds 8-2-4 | 1 | 28.5 | 0.3 | --- |
| No fertilizer | 2 | 31.5 | --- | 17.5 |
| 300 pounds 8-2-4 | 2 | 37.8 | 6.3 | --- |
| No fertilizer | 3 | 32.3 | --- | 18.3 |
| 300 pounds 8-2-4 | 3 | 38.4 | 6.1 | --- |
| No fertilizer | 4 | 32.0 | --- | 18.0 |
| 300 pounds 8-2-4 | 4 | 38.9 | 6.9 | --- |

Each year that the experiment was continued, the increase due to the use of fertilizer became greater. The use of limestone increased the yields in all cases.

General Fertilizer Experiment. In this experiment different sources of phosphoric acid, as superphosphate, basic slag and finely ground rock phosphate were compared as to their relative efficiency as carriers of phosphoric acid when used on this soil. Crops of corn, oats and Irish potatoes are being

grown each year. Phosphoric acid in none of the above forms has greatly increased the yield of any of the crops. Potash, applied as manure salt, has in all cases practically doubled the yields of corn, oats and Irish potatoes. The use of a fertilizer containing phosphoric acid and nitrogen, but no potash, has in no instance been profitable.

AT TOBACCO BRANCH STATION (Durham Sandy Loam)

The experimental work conducted at this farm, near Oxford, has been carried on during the past year in the regular way in coöperation with the office of Tobacco Investigations of the U. S. Department of Agriculture. The regular plat work has consisted of seventy-five one fortieth acre plats devoted to fertilizers experiments. Twenty plats were used for testing different rates of applying potash and comparing muriate with sulphate; eighteen for testing the different sources of potash with dolomitic and calcitic limestones; eleven were used in determining the quantity of magnesia required to prevent sand-drown; twelve in which pure chemicals were used in an effort to determine the relative value of magnesia, sulphur and chlorine in combination with a complete fertilizer under tobacco. Eighty-six plats were also used for testing the relative merits of the different sources of nitrogen. Tests were also made with tobacco by the addition of liberal amounts of potash and superphosphate after plowing under soybeans. Three different systems of rotation tests were carried on, as well as work with cotton, corn, and tobacco in combination with wheat, oats and rye following vetch, clover, soybeans, cowpeas and grass. A more detailed study of the effect of sulphur, chlorine and magnesia was continued along the same lines as of last year. The distance of planting and variety tests were also continued along lines as conducted in previous years.

In addition to the variety work, which has been carried on heretofore, a considerable amount of work was done in making selections from the two most outstanding varieties, viz., White Stem Oronoco and Cash. The State Department of Agriculture provided funds for putting on a trained man to assist in this line of work. The indications are that some valuable results will be obtained along this line.

Continued work has been carried out in testing a few cotton varieties and selection of corn.

The Station was able to construct one cinder block and one clay tile curing barn during the past season. These barns have proved to be very satisfactory for curing tobacco. The cinder block barn is now being converted into a sweet potato curing house in which sweet potatoes will be cured out during the fall season. Studies are being conducted in coöperation with the Federal Offices of Tobacco Investigations along the line of the chemical composition of the tobacco leaf.

Two tobacco bulletins embodying results secured at this farm (Tech. Bul. No. 12 of the U. S. Department of Agriculture and the June, 1927, Bul. of N. C. Department of Agriculture) have been prepared and published since the last report. These bulletins give detailed reports of the fertilizer experiment and results secured with flue-cured tobacco.

RESULTS ON SOIL-TYPE FIELDS WITH FARMERS IN DIFFERENT PARTS OF THE STATE

Soil fertility experiments were continued during the year on various typical soil types of the State in coöperation with individual farmers to determine crop fertilizer requirements when grown on these soils.

On Ashe Loam. The results in Burke County with corn in 1927 show that phosphoric acid is one of the main limiting factors for the most profitable production. Good increases were noted when phosphoric acid up to 24 per cent was used in 400 pounds per acre of a complete fertilizer mixture carrying 4 per cent nitrogen and 2 per cent potash. Little potash seemed to be needed for corn grown on this type of soil. Ground limestone proved beneficial, as the use of 2,000 pounds of it gave an increase in yield of about twelve bushels per acre.

On Applying Sandy Loam. The results with cotton in 1927 in Davie County showed that a 10-5-3 mixture is better than a 10-5-7 fertilizer, both as to yield and earliness of maturity. In this experiment Trona muriate of potash showed up this year as a better carrier of potash in the fertilizer mixture than did either ordinary muriate or kainit.

On Cecil Clay Loam. On this type of soil in Mecklenburg County the use of 200 pounds of nitrophoska, analyzing approximately 36-17-13, applied in the drill produced a larger yield than did any other mixture tried out in this experiment for cotton. Among other things being sought in the experiment is the best proportioning of phosphoric acid, nitrogen and potash for cotton. With the phosphoric acid varying by 2 per cent increments from 6 to 12 per cent in a complete mixture carrying 5 per cent nitrogen and 3 per cent potash, the best and most profitable yield was secured from 10 per cent of phosphoric acid in the mixture. In a complete mixture applied in the drill at planting, carrying 10 per cent available phosphoric acid and 3 per cent potash with the nitrogen varying by 2 per cent, increments from 3 to 7, the largest yield was obtained where 5 per cent nitrogen was put in the mixture.

With the content of potash varying by 2 per cent increments from 1 to 5 per cent in a complete fertilizer mixture carrying 10 per cent available phosphoric acid and 5 per cent nitrogen, the largest and most profitable yield was obtained where 5 per cent potash was contained.

On Davidson Clay Loam. Wheat on this soil in Davie County during 1924 and 1927 gave better results from a 12-3-3 fertilizer when all of the nitrogen as nitrate of soda was applied broadcast in the early spring, the phosphoric acid and potash having been applied in the fall at seeding time, than when half of the nitrogen as nitrate of soda was applied in the fall with the phosphoric acid and potash and the other half used as a broadcast application during the following spring.

Corn has given better results when all the nitrogen as nitrate of soda is applied along the side of the rows about July 1, than when half of it was applied at planting time in the drill and the other half reserved and applied as a top dressing about July 1.

On Iredell Sandy Loam. Results with corn on this field in Davie County in 1927 in which a comparison of equal quantities of a 10-6-2, 10-6-4,

and 10-6-6 was made, have shown that as the percentage of potash in the mixture is increased, the yield is progressively increased from 36 to 45 bushels per acre. Trona muriate of potash has thus far proved a better source of the potash than muriate of potash or kainit.

FIELD EXPERIMENTS IN COOPERATION WITH FEDERAL BUREAU OF CHEMISTRY AND SOILS ON IMPORTANT SOIL TYPES

On Davidson Clay Loam. Experiments conducted on this soil in Davidson County in 1927 have shown that for the most profitable growth of cotton, liberal quantities of phosphoric acid and nitrogen are required. The use of potash, although giving good returns, did not lead to as great gains in yields as did the use of the other two constituents. In a study of the value of varying quantities of an 8-4-4 mixture, where the quantity ranged from 0 to 1,000 pounds per acre the best yields were secured from the heavier applications. The use of 800 pounds per acre more than doubled the yield of plats receiving no fertilizer.

Of the different sources and combinations of sources of nitrogen in 800 pounds per acre of an 8-6-4 mixture, ammophos gave the largest yield of seed cotton per acre. The next best results were secured from nitrate of soda and a mixture of sources consisting of one-fourth from nitrate of soda, one-fourth from sulphate of ammonia, and one-half from tankage. The poorest yield was secured from ammonium chloride, with the potash derived from muriate of potash instead of sulphate of potash, the latter being the source used on all the other plats to supply the requisite amount of potash. On this soil sulphate of potash, as the source of potash in a 7-5-4 fertilizer mixture, proved to be a better carrier of this constituent than did either muriate of potash or kainit, when the phosphoric acid was supplied by superphosphate and the nitrogen by one-third from nitrate of soda, one-third from sulphate of ammonia and one-third from cottonseed meal.

On Cecil Clay Loam. In this experiment with cotton in Mecklenburg County, 900 pounds per acre of a fertilizer analyzing 9-6-3 was used in which the phosphoric acid, nitrogen and potash were derived in the different plats from some of the following concentrated materials: Ammophos, potassium ammonium phosphate, potassium nitrate, ammonium nitrate, ammonium sulphate, ammonium chloride, urea, triple phosphate, superphosphate, potassium sulphate, sodium nitrate combined with very small amounts of cottonseed meal or with cottonseed meal, blood and fish scrap to give the mixtures a good mechanical condition. With all the mixtures placed in the drill at planting time, no difficulty was experienced in securing and maintaining a very good stand on any of the plats. This observation is contrary to many findings with heavy applications of concentrated materials on some of the soils of the Coastal Plain section of the State.

On Cecil Sandy Loam. Results with sweet potatoes in this experiment, conducted in Catawba County in 1927, show that all three plant food constituents are necessary to be added for best returns. However, indications are that phosphoric acid is a little more needed than either of the other two. In a study of the most profitable rate of two mixtures (8-4-4 and 8-4-8) used

at the rate of 500, 750 and 1,000 pounds per acre in the drill at planting, higher corresponding yields were secured from the 8-4-8 than from the 8-4-4 mixture. This year the most profitable yield was secured from the use of 750 pounds of the 8-4-8 mixture. As sources of potash, using an 8-4-6 mixture, kainit gave a little higher yield than did either muriate of potash or sulphate of potash on this soil.

Organic sources of nitrogen averaged a little better than did the inorganic for sweet potatoes, although best returns were secured when one-half the nitrogen each came from cottonseed meal and nitrate of soda.

On Norfolk Loamy Fine Sand. When applications of an 8-4-8, 8-3-5, and 8-3-6 mixtures varying from 1,000 to 2,000 pounds per acre were used with sweet potatoes on Norfolk loamy fine sand in Currituck County, the largest yields were secured from the heavier applications of 1,800 to 2,000 pounds per acre. The yields from these quantities were about four times as great as from the unfertilized areas.

Nitrate of soda, used as the sole source of nitrogen was very injurious to the young potato plants. A very poor stand was secured on this plat as well as on the one receiving 8 per cent potash derived entirely from kainit with 8 per cent available phosphoric acid and 4 per cent nitrogen. The unusually dry season that prevailed about the time the plants were set was undoubtedly responsible for making the injury more pronounced this year. The results of this year conform to those of 1926 in showing that the nitrogen in a fertilizer mixture for sweet potatoes should be derived partly from mineral sources as nitrate of soda or sulphate of ammonia, and partly from organic sources such as cottonseed meal or fish scrap. The indications point to the necessity of a relatively high percentage of potash in the fertilizer mixture. A potato mixture for the light sandy soils of this character should, it appears at this time, contain about 8 per cent phosphoric acid, 3 to 4 per cent ammonia and about 8 per cent potash.

On Marlboro Sandy Loam. On this experiment with cotton in Wilson County, using varying proportions of plant-food constituents on the different plats at an equivalent of 900 pounds per acre, the one giving the largest yield (1,784 pounds seed cotton) analyzed 6 per cent available phosphoric acid, 6 per cent ammonia and 3 per cent potash. This mixture produced almost 2.3 times as much seed cotton per acre as did the unfertilized plat adjoining it.

As sources of nitrogen for cotton, results this year have shown that one-half from inorganic and one-half from organic is better than having all derived either from nitrate of soda or sulphate of ammonia. Varying the application of an 8-4-6 mixture from 300 to 1,500 pounds in the drill at planting of the cotton, the increase in yield and profit from the application was progressive with the applications up to 1,200 pounds per acre.

On Orangeburg Sandy Loam. In this experiment with cotton in Northampton County, using an 8-6-4 fertilizer, a mixed source of nitrogen (organic and inorganic) proved better than any of the inorganic sources included, such as nitrate of soda, nitrate of ammonia, muriate of ammonia, phosphate of ammonia and leunasalpeter. On this field sulphate of ammonia has, during the past two years, given a higher yield of seed cotton per acre than has

nitrate of soda as the sole source of nitrogen when using 900 pounds per acre of a fertilizer analyzing 8-6-4. In a study of the relative value of varying quantities of this mixture, applications averaging from 300 to 1,200 pounds were put in the drill at planting of the cotton. The most profitable application was 1,200 pounds per acre, which was 3.7 times the yield of the unfertilized plot. The use of concentrated mixtures, contrary to the experience previously mentioned in connection with the experiments on Cecil clay loam, has in all cases reduced the stand of cotton.

On Bladen Fine Sandy Loam. In this experiment with Irish potatoes, conducted during the spring of 1928 in Beaufort County, a comparison was made of the relative value of 7-5-5, 6-7-5, and 7-5-7 fertilizers (these mixtures being quite commonly used in the community) used in the drill at planting at the rates of 1,600, 2,000 and 2,400 pounds per acre. The 7-5-5 mixture gave a larger yield than did either the 6-7-5 or 7-5-7 mixture. Two thousand pounds per acre gave a larger yield than did the use of either 1,600 or 2,400 pounds where the 7-5-5 and 6-7-5 mixtures were used, but with the 7-5-7 mixture 2,400 pounds gave a little larger yield than did 2,000 pounds.

On the basis of results of this year, 2,000 pounds of the 7-5-5 mixture is the most economical fertilization for potatoes.

From that portion of the experiment designed to study the best proportions of ammonia and potash in the mixture with 6 per cent of phosphoric acid, it was found by varying the ammonia from 0 to 10 per cent with 5 per cent of potash that the yield was materially increased by each increment up to 10 per cent. Varying the potash from 0 to 10 per cent in an application of 2,000 pounds per acre of a mixture containing 6 per cent available phosphoric acid and 7 per cent ammonia, the highest yield was secured when 6 per cent of potash was contained in the mixture. Using 2,000 pounds of a 6-7-5 mixture, muriate of potash gave 29 bushels more per acre than did manure salt as the source of potash. From one year's results the best sources of ammonia for a fertilizer to be used under Irish potatoes on this soil is one in which the nitrogen was derived equally from sulphate of ammonia and cottonseed meal; from ammophos; equally from nitrate of soda and from cottonseed meal; and from urea in the order given.

CROP IMPROVEMENT AND CULTURAL WORK, INCLUDING A SPECIAL STUDY OF COTTON FIBER

Inheritance Studies with Cotton. This work has been carried on for several years. During the past year a technical bulletin on the inheritance of the naked or fuzzless seed coat of seed of the crop was prepared for publication. A strain homozygous for naked seed was crossed on a strain homozygous for fuzzy seed. In the F_1 plants, all bore naked seed, while the F_2 plants segregated in the ratio of 3 to 1. The naked condition of the seed coat was dominant.

The manner in which the fuzzy-tip character of seed is inherited is now being studied. This character often shows up in upland varieties of cotton. The seed are entirely free of fuzz, except for a small tuft at the tip end of the seed, they having somewhat the appearance of the seed of Sea Island cot-

ton. Several plants, having fuzzy tipped seed, were found in the Cleveland Big Boll variety. By selection and self-pollination a strain, homozygous for the fuzzy-tip character, was secured. This was crossed on both the pure naked and the pure fuzzy strains. The F_1 plants were grown in 1927. The cross fuzzy-tip X naked produced twenty F_1 plants, all of which bore naked seed. The cross fuzzy-tip X fuzzy gave six F_1 plants, all of which bore fuzzy-tip seed. This indicates that the naked condition of the seed coat is dominant to all grades of fuzziness, and that less fuzz is dominant to more fuzz. The F_2 generation is being grown in 1928.

Cotton Improvement. Pure-line selection work is being carried on with the Mexican Big Boll variety at the Central Station farm; at the Upper Coastal Plain Branch Station; and at the Piedmont Branch Station. Pedigreed strains of this variety have been grown on these farms for several years, a large number of plant-to-row selections having been grown each year. The best of these have gone in the strain test the following year. The poorer ones have been gradually discarded and the best ones have been increased as rapidly as possible. The entire crop, with the exception of the breeding plats, has been planted to the best strain as soon as sufficient seed have been secured. Factors taken into consideration in selecting the best strains have been as follows: Yield per acre, length of lint, uniformity of lint, size of boll, uniformity of plant type, and earliness. These characters are found to vary to some extent, even in the strains selected from a well-bred variety, as is shown by the following data on a few strains in the strain test at the Upper Coastal Plain Branch Station farm in 1927:

| Strain Number | Yield of Lint Pounds | Per cent Open First Picking | Per cent Lint | Staple— Inches |
|----------------------|----------------------------|-----------------------------------|------------------|-------------------|
| 2..... | 567 | 46.7 | 36.0 | 1-1/16 |
| 26..... | 492 | 59.2 | 35.2 | 1-1/16 full |
| 87..... | 550 | 46.1 | 35.2 | 1-1/16 full |
| 32..... | 544 | 44.5 | 38.6 | 1-1/16 |
| 55..... | 480 | 40.0 | 35.5 | 1-1/16 full |
| Parent Variety | 520 | 50.0 | 35.4 | 1-1/16 |

Spacing. Under boll weevil conditions it is very important to secure early fruiting and to control vegetative growth of the cotton. Spacing experiments on the Upper Coastal Plain Branch Station farm show that hills spaced nine inches apart in four-foot rows and one to two plants to the hill, produce larger yields and earlier fruiting than wider spacings. Cotton chopped a hoe width, having an average of two plants to the hill, will give 20,000 plants or more per acre. These plants producing an average of five bolls per plant will produce a bale of cotton to the acre. Counts on the plats having three plants to the hill have shown that in 50 per cent of the hills only two plants developed sufficiently to produce bolls.

The following are the average results of three years' experiments (1925-27) at different distancing of the hills in the rows and plants per hill at this farm:

| Distance Between Hills | Inches | Plants per Hill | Yield Seed Cotton per Acre— Pounds | | Per Cent Total Yield Open First Picking |
|------------------------|--------|-----------------|---------------------------------------|-------------|---|
| | | | First Picking | Total Yield | |
| 9 | ----- | 1 | 720 | 1800 | 40 |
| 9 | ----- | 2 | 810 | 1820 | 44 |
| 9 | ----- | 3 | 735 | 1650 | 45 |
| 12 | ----- | 1 | 645 | 1700 | 38 |
| 12 | ----- | 2 | 735 | 1740 | 42 |
| 12 | ----- | 3 | 735 | 1680 | 44 |
| 15 | ----- | 1 | 480 | 1550 | 31 |
| 15 | ----- | 2 | 645 | 1650 | 39 |
| 15 | ----- | 3 | 630 | 1720 | 37 |
| 18 | ----- | 1 | 450 | 1440 | 31 |
| 18 | ----- | 2 | 585 | 1530 | 38 |
| 18 | ----- | 3 | 615 | 1620 | 38 |

Results secured at the Piedmont Branch Station were about the same as those at the Upper Coastal Plain farm.

Time of Applying Fertilizer and Ridging Land. Applying the fertilizer and ridging 10 to 20 days before planting time was compared with applying fertilizer and ridging at the time of planting. The early application of fertilizer and ridging has usually given better results than the fresh preparations, particularly during the dry seasons at planting time. There is less fertilizer injury to the seed and seedlings, and the seed-bed is more compact and more moist if the season is dry as shown by the results of three years on these two farms:

| Location | Soil Type | Prepared Early | Prepared and Planted Fresh |
|----------------------------------|--------------------------|-------------------|-------------------------------|
| Upper Coastal Plain Station..... | Norfolk sandy loam | 1,432 lbs. | 1,335 lbs. |
| Piedmont Station..... | Cecil sandy loam | 1,160 lbs. | 990 lbs. |

Better stands were generally secured on the early prepared plats.

Variety Tests With Cotton. These tests show that the varieties producing an inch to an inch and one-sixteenth staple will bring greater money returns per acre than those producing a shorter staple.

Soybean Varieties. Soybean variety tests are carried on at the Central Station and on four of the Branch Station farms. These tests include the varieties commonly grown in the State, a number of varieties not generally grown and many new varieties and selections recently brought in by the U. S. Department of Agriculture from other countries. Some of these recent introductions are quite promising, while many others are of very little value. Data

were secured on type of plant, foliage, pod and seed, date of maturity, uniformity, and yield of hay and seed per acre.

Improvement of Soybeans. Selection work along certain lines is being carried on. Work on the development of a non-shattering bean of the Mammoth Yellow type is under way. A number of Biloxi hybrids have been grown and selection work is being continued in the hope of getting a yellow bean of the Biloxi type which will yield better than the brown Biloxi.

Winter Legumes for Cover and Hay Crops. Hairy vetch and wooly podded vetch are the most satisfactory vetches for soil improvement and hay purposes. Hairy vetch produced more growth than either crimson clover or Austrian winter field peas on the Coastal Plain Branch Station farm at Willard. It also produced a much better growth than did the Austrian winter field pea on the Blackland Station at Wenona. It did not winter kill, while the Austrian pea killed badly, and was damaged badly by the ascochyta leaf spot. Hairy vetch gave better results when seeded with a small grain, but it fell down badly when seeded alone. A mixture of hairy vetch, hooded barley and oats is one of the best fall sown hay crop mixtures for North Carolina farmers.

Although the Austrian winter field pea shows some promise as a winter soil-improving crop, it is not sufficient to recommend it over hairy vetch. It makes a slightly earlier growth, but dies out badly about blooming time, due to the ravages of leaf spot and other diseases.

Small Grain Cover Crops. Abruzzi rye, hooded barley and oats were seeded on the Coastal Plain Branch Station and on the Blackland Branch Station farms. Abruzzi rye proved more winter-hardy than either oats or barley. The rye did not winter-kill on either the Norfolk or the peat soils; barley winter-killed badly on both types of soil; and oats winter-killed badly on the Norfolk soil, and were entirely killed on the peat soil. Abruzzi rye made by far the best winter growth. On March 15 it was 15 inches high at Willard, while oats and barley had not made enough growth to furnish much green material for pasture or for turning under. The yields of hay at the Coastal Plain Branch Station farm were as follows:

| | |
|--------------------------------|-----------------------|
| Abruzzi rye ----- | 2,520 pounds per acre |
| Fulghum oats ----- | 1,410 pounds per acre |
| Virginia winter gray oats----- | 2,610 pounds per acre |
| Winter Barley ----- | 840 pounds per acre |

The Virginia Winter Gray oat was much more hardy than the Fulghum, but is much later and not as desirable in other respects. The winter of 1927-28 was one unusually severe on small grains, which emphasizes the need for an early oat which will be more hardy than either the Fulghum or Appler variety.

Sources of Red Clover Seed. In the spring of 1926 work was begun with red clover to determine the adaptability of seed from different sources. The total yields of hay per acre from the first and second cuttings made during the summer of 1927 are as follows:

| Source of Seed | Hay Yield - Pounds |
|----------------------------------|-----------------------|
| Maryland..... | 3270 |
| Ohio..... | 3030 |
| Michigan..... | 2420 |
| Oregon..... | 2300 |
| Minnesota..... | 2200 |
| Chilean..... | 2220 |
| French..... | 2150 |
| American grown (commercial)..... | 1980 |
| Imported (commercial)..... | 1860 |
| Italian..... | 950 |

The plats seeded with Italian seed were very badly damaged by disease, more than 50 per cent of the plants being dead by the second cutting. Very little disease, except mildew, was found on the plats planted to other strains.

RESULTS OF CROP IMPROVEMENT EXPERIMENTS WITH CORN

At Central Farm. Corn improvement by seed selection is carried on at the Central and at the six Branch Station farms. The methods used are limited to general field selections, special seed patches, and ear-to-row method.

At Mountain Branch Station. The original variety chosen for foundational work at this farm was Biggs' Seven Ear, a very prolific variety. As most farmers object to shucking the numerous small ears characteristic of a very prolific variety of corn like this, selections were made from the very beginning for stalks bearing two good ears and for grains with smooth caps. A distinct strain has been developed that is very popular with the superintendent of the farm and with others who have given it a field trial. The last corn variety test of a five-year consecutive period was conducted on this farm in 1918. In 1926, after an interval of seven years the variety test was again resumed for the purpose of checking by comparative yields the strain developed on the farm with varieties customarily grown in that section of the State. In the test for the season of 1926 this strain ranked sixth in yield of bushels per acre, and in 1927 it ranked fifth. There were nine varieties in the first and thirteen in the second test. This strain appears to have too many good qualities to be discarded. Its yielding power must be increased by future selections to that end.

One of the leading varieties grown in the Mountain section of the State is Holcombe's Prolific. In the first test on this farm it ranked first in acre-yield, with a difference of 25.9 bushels per acre between it and the lowest variety, Hickory King. In the second test it ranked second in acre-yield with a difference of 23.2 bushels per acre between it and the Hickory King variety.

At Piedmont Branch Station. The original variety from which the selections were made was Weekley's Improved. In a test of ten varieties at this farm in 1926, this strain ranked first in acre-yield. In 1927 in another test of ten varieties, it ranked second in yield. By actual count the plat

(1/20 acre) on which this strain was grown had seventeen stalks fewer than the plat of the same size upon which the variety ranking first was grown. Doubtless the difference in yields was due to the difference in stands. These two tests indicate that a real contribution has been made in a high-yielding variety of corn adapted to Piedmont North Carolina. Two tests, however, do not definitely decide the question.

At Central Station. On this farm an effort has been made to improve a strain of Cocke's Prolific, one of the standard prolific varieties for this part of the State. This strain ranked fourth in acre-yield in the two tests of nine varieties each for 1926 and 1927. The selections have not been in progress as long as at the two farms mentioned above. The test in 1927 was as near perfect as can be expected under field conditions.

At Tobacco Branch Station. The original seed corn for this farm is Weekley's Improved and was secured from the Piedmont Branch Station. Systematic field selections have been made annually for the past seven or eight years, resulting in a distinct strain. How it compares with the strain developed on the Piedmont Branch Station farm in either distinguishing characters or yield has not yet been determined by a comparative test. No variety test is conducted on this farm, and it was entered in the test at the Central Station farm for the first time in 1928. The superintendent of the farm is highly pleased with it. Each season enough seed of it is selected in the field to plant the entire crop the next year. A special seed patch is grown each season, the seed from which is used in planting the field from which the selections are made for planting the general crop.

At Upper Coastal Plain Branch Station. The work on this farm has been confined to field selections and occasional ear-to-row tests. The original variety was Latham's Double. This is a variety that in numerous tests throughout Eastern Carolina has proven its comparatively high yielding powers. So far nothing more has been accomplished with it on this farm than maintaining its high yielding standard. It does not produce a very uniform ear, and there is room for improvement along this line.

At Coastal Plain Branch Station. Cocke's Prolific is the variety grown on this farm. The seed were obtained from the Central Station farm at Raleigh. Something has been accomplished, but the amount has not yet been definitely determined. A variety test to determine what has been accomplished and to test out some of the local varieties has been put out this year. Twelve varieties were included in this test, mainly the varieties grown at the Coastal Plain area of the State, including three varieties sent in by the county agent of Pender County. Stress has been laid upon the special seed patch in the work on this farm.

At Blackland Branch Station. Nothing more has been done than lay the foundation. Two preliminary variety tests have been conducted in an effort to determine the variety best adapted to muck soil. Highland Horsetooth, a strain of the old-fashioned horsetooth variety developed by D. W. Bagley, of Moyock, was selected for use on this farm. The first field selections were made from it during the season of 1927. It is planned to keep up this selection work for several years.

RESULTS OF CROP IMPROVEMENT EXPERIMENTS WITH SMALL GRAINS

The recent work with small grains has consisted in testing out varieties and establishing standards by which future work can be measured. Selections have not yet been undertaken on account of a lack of equipment for handling. The small grain work has been conducted on the farms at both the Mountain and Piedmont branch stations.

Wheat. The same varieties were carried in the tests on both the farms. The results of the wheat variety test conducted at the Mountain farm for the past six seasons show Fulcaster, Leap's Prolific and Purple Straw to be the best yielders. One year's results show Alabama Blue Stem and V. P. I. are superior yielders.

One interesting feature of the wheat work was a comparison of the relative adaptability of upland and bottomland for wheat production. The popular idea is that upland is better adapted to wheat production than bottomland, and that when wheat is to be grown on bottomland a bearded variety will out-yield a smooth variety. It was to prove or disprove these popular notions that the test was conducted. Six years results have shown the following:

(1) Upland is better adapted for wheat growing than bottomland. Fulcaster and Leap's Prolific averaged 3.8 and 5.4 bushels more respectively, per acre on upland than when grown on bottomland.

(2) Fulcaster, a bearded, rust-resistant variety, is better adapted to bottomland than Leap's Prolific, a smooth rust-susceptible variety. Fulcaster averaged 15.4 per cent less on bottomland than on upland, while Leap's Prolific averaged 23.5 per cent less.

(3) Wheat seeded on bottomland is much more likely to winter-kill than when grown on upland.

The opinion is that, as a general rule, wheat is seeded too late in the mountain section of the State. To prove or disprove this opinion a date of seeding test was undertaken on this farm in the fall of 1927. The results thus far secured show best returns from seedings made on September 15 and October 15. This test is to be continued until more trustworthy data has been obtained.

The same varieties tested in the mountains are carried in the wheat variety test at the Piedmont farm. As this farm is located in the main wheat growing belt of the State, the results obtained will be very significant to a large number of wheat growers. There has been some shifting of the different varieties in respect to rank according to acre-yields in two different tests. Fulcaster, a bearded rust-resistant variety, however, has led in both tests. The results in grain yields of bushels per acre for the past six seasons show Fulcaster first, with Gleason, Purple Straw and Leap's Prolific coming next in the order given.

Rye. A test of Abruzzi and common varieties of rye on the Mountain Branch Station farm was discontinued at the end of the five years in 1927. The grain results show no striking differences in the yields of these two ryes.

The tests of Abruzzi and common rye varieties were also discontinued on the Piedmont Branch Station farm with the season of 1927. At this farm

there was a difference in yield of 4.5 bushels per acre in favor of the Abruzzi variety. The future work with rye on this Branch Station farm is to consist in the development of pedigreed and pure strains of the Abruzzi variety.

Barley. No barley variety test has ever been conducted on the Mountain Branch Station farm. A plat was seeded to hooded barley for two or three seasons alongside of the wheat plats to determine how well this crop would withstand the severe freezing weather of the winters. It stood up well until the winter of 1927-28, when it was completely winter-killed.

A test for comparative yields has been conducted on the Piedmont Branch Station farm for the past six seasons. Tennessee No. 6 is one of the very best hooded varieties thus far found. One important phase of the barley work at this farm is to develop an unmixed strain of the North Carolina strain which will be hooded.

Oats. The variety test in 1928 showed the Appler and Richland varieties the best yielders of spring-sown oats conducted on the Mountain Branch Station farm.

Two varieties of fall-sown oats, commonly grown in Piedmont North Carolina, the Fulghum and the Appler, have been grown with the Lee variety in a test for comparative yields on the Piedmont Branch Station for the past six years. The standing of the varieties up to this time are Lee, Appler and Fulghum in the order given.

PHYSICAL PROPERTIES OF COTTON FIBERS IN RELATION TO YARN QUALITY AND COTTON IMPROVEMENT

This project is an attempt to isolate certain physical qualities of cotton fibers and more accurately measure their value for spinning with the idea of using the information as a basis for further improvement of cotton quality in North Carolina. Conferences with mill operators and cotton buyers have indicated that certain qualities which make up texture are important in spinning. The term "drag" has been used to denote one of the physical qualities. As used by cotton breeders and classers, "drag" is the resistance experienced when a sample of cotton is pulled into two parts by the forefingers and thumbs. The studies of "drag" and other physical qualities in relation to spinning have been made in coöperation with the United States Department of Agriculture and the Textile School of the College. Recent results of these studies have been published in Technical Bulletin No. 33 of the Station. The following is a summary of the findings reported in this bulletin:

1. An accurate method for measuring "drag" has been developed. Two small hand cards were used to secure uniform preparation of samples; a small wooden clamp was used for securing uniform density, and a single-strand yarn tester was used for measuring the strength of "drag."
2. Examination of fifteen bales of cotton resulted in finding two bales of similar grade and length which showed contrast in "drag," the ratio being 100:145.4. Both bales were reserved for further studies. The bale with weak "drag" was designated No. 1, and the one with the strong "drag" No. 2.
3. Samples of the bales were submitted to technical departments of several mills and their reports indicate recognition of the difference in texture by describing No. 1 as soft, and No. 2 as medium to harsh cotton.

4. Measurements of "drag" were made from samples of the bales in the raw state after the carding, drawing and roving processes were concluded. A difference persisted throughout, though the contrast was not so great after the drawing process as was noted in the hand-carded samples.
5. The "drag" of sliver from the cards was measured after exposure to different degrees of humidity. The results indicate that as the humidity increased, the strength of "drag" decreased.
6. After mechanical twist was given to the sliver, the stronger "drag" did not give an advantage in strength. Yarns from the bale having weak "drag" were stronger.
7. Bale No. 2 contained slightly more waste than No. 1. No other difference was noted in the running quality of the bales.
8. Yarns from the bales were tested for strength and stretch at different humidities. An increase in humidity was associated with a pronounced increase in the strength and stretch of both bales. A higher humidity influenced more favorably the strength of yarns from the bale with stronger "drag." At the different degrees of humidity used in the tests, the strength and stretch of yarns from the bale with weaker "drag" were considerably greater than was noted in the yarns of the bale with the stronger "drag."
9. A study of the relation of twist per inch in yarns and strength of "drag" showed that the bale with weaker "drag" produced stronger yarns at both the minimum and maximum turns per inch in counts ranging from 26s to 35s. An increase in turns per inch above the minimum was accompanied by a greater increase in the strength of yarns from the bale with stronger "drag."
10. Other physical properties of fibers from the two bales were studied. Fibers of the bale with weak "drag" were more uniform in length; their average length was slightly less. Fibers of the soft bale were wider in ribbon width and showed considerably less development of fiber walls. The results indicate that development of fiber walls and "drag" are associated.
11. Spinning tests were made on four other bales of cotton which showed contrast in drag. In most cases stronger yarns were manufactured from the bales with weaker "drag."
12. The data from all completed tests in this bulletin indicate that high strength of "drag" is not necessarily a prerequisite to greater yarn strength and running quality of cotton.

The studies of "drag" will be continued, though efforts are being made to find simpler physical qualities that may have an influence upon spinning quality. Since lack of cell wall thickening is apparently associated with softer texture and weaker "drag," further evidence upon the conditions under which the thickening and lack of thickening in the fiber cell wall might be of value. Judging from the classification of cotton submitted to cotton experts, the trade is accustomed to classing the softer cottons as fine, and the harsher cottons as medium to coarse. Previous results of R. C. Campbell, at this station, has shown that there is a direct relation between density of fiber population on the seed coat and the amount of thickening of the fiber cell wall, the denser population being associated with thinner walls. Several hundred examinations have been made of fibers from several varieties and strains of approximately the same fiber length. Other examinations of green fibers at a point of development just prior to the time thickening takes place have shown no significant differences in the width of collapsed fiber cells. Examination of cotton samples from fertilizer plats gave some significant differences in cell wall thickening, but sufficient data have not been secured to draw definite conclusions. The results from this work and the effect of crowding on the seed coat would indicate a nutritional, and possibly a moisture relation.

RESEARCH OF THE TEACHING STAFF

W. B. COBB, *Professor of Soils*

Technical Studies on the Durham Series of Soils. A number of samples of soil types of the Durham series have been collected and field observations made on their physical characteristics. It has been noted that the subsoils of some of the samples collected are very friable in consistency and low in clay content. A microscopic examination of sand grains from these samples shows that they contain a high percentage, from 15 to 20, of potash-bearing minerals such as orthoclase, microcline and muscovite.

Other samples have compact clay subsoils. The sands of these samples consist almost entirely of quartz showing a more advanced stage of weathering and evidences of the leaching out of potash, and probably also of lime, magnesia and soda.

Lack of laboratory facilities and time have made it impossible during the year to follow up this work with chemical analyses. It is apparent, however, that there are two distinct soils now mapped as Durham, and it is thought advisable to locate fertilizer tests on the two phases of soil for the purpose of determining if there is any agricultural difference, or difference in fertilizer response.

It is planned to continue work on this project and work out a recommendation for a change in classification, if the physical and chemical differences in the two phases of the soil are found to be correlated with agricultural differences.

THE EFFICIENCY OF ONE, TWO, FOUR-HORSE AND TRACTOR
OUTFITS FOR PLOWINGD. S. WEAVER, *Professor of Agricultural Engineering*

The increasing use of larger power units, both animal and mechanical, prompted this comparison of the ability of the above units in plowing. The experiment was conducted on the farm of W. T. Moss, Franklin County, where both horses and tractors are used. The type of soil is Cecil clay loam.

| Source of Power | Plow Size | Square Feet per Hour | Acres per 10-hour Day | Labor Cost per Acre— Man, 20¢ per Hour; Horse, 15¢ per Hour; Tractor, 80¢ per Hour |
|--------------------|---------------|-------------------------|--------------------------|---|
| 1 horse | 6" | 6,394 | 1.467 | \$2.38 |
| 2 horse | 10" | 9,262 | 2.126 | 2.35 |
| 4 horse | 2-10" | 16,410 | 3.767 | 2.12 |
| 4 horse | 2-10" | 20,992 | 4.821 | 1.65 |
| 10-20 tractor..... | 2 bottom disc | 20,040 | 4.60 | 2.17 |

Both four-horse teams were hitched tandem, two and two, using the improved non-rigid hitch. The excellent showing made by the four-horse team which plowed at the rate of 4.821 acres per day as compared to that made by the other four-horse team, emphasizes the benefits of good horsemanship, as this team has worked as a unit and been driven by one driver for five years.

The other four-horse team was hitched in this manner for the first time, and awkwardness was very evident. The horse used with the 6-in. plow was a stallion and his unusual vigor resulted in plowing at the rate of 1.467 acres per day, which greatly exceeded the rate per horse of any other team.

The last column showing acre plowing costs was calculated with figures prevailing in that community.

The accompanying photograph shows the type of land used in the experiment, and the team and plow which plowed at the rate of 4.821 acres per day.



Plowing with four horses in tandem.

EFFICIENCY STUDY OF ONE AND TWO-HORSE CULTIVATORS IN COTTON PRODUCTION

The greatly increased use of two-horse riding cultivators has raised questions regarding their efficiency as compared to the common one-horse type. The purpose of this project was to bring out certain facts regarding the ability of each to thoroughly cultivate the cotton crop and the relative cost in man and horse labor to operate each.

The four cultivations needed by the crop were all observed and the time consumed in the cultivation of equal areas by each machine was found to be exactly twice as great in the case of the one-horse as that of the two-horse implement. With man labor at 20c per hour and horse labor at 15c per hour, the labor cost per acre cultivated was 40 per cent greater with the one-horse type.

In optimum soil conditions and with a very careful operator during the first cultivation, it was observed that the one-horse cultivator could cultivate closer to the row with less damage to the crop, but in the hard places in the



The one-horse cultivator.



The two-horse riding cultivator.

field the operator could not prevent plowing out and covering more of the crop than did the two-horse type, with its greater weight and ease of control. Careless operation or even average operation of the one-horse type indicates the great superiority of the two-horse cultivator as regards thoroughness in cultivating. One very striking comparison in favor of the two-horse type which was noted is the fact that in extremely hard ground, penetration could not be secured with the one-horse implement except with the use of 2-in. shovels, which failed to destroy the grass between the rows. The two-horse type with its greater weight and accuracy of control in the same hard ground was equipped with sweeps which completely removed the grass.

As regards best cultivation in crossing terraces it was observed that on rows running at right angles to the terrace bank the two-horse implement could be adjusted by means of the leveling lever to do as thorough work as the one-horse type, but where a leveling lever was not provided, or, when provided, was not used, the one-horse implement cultivated the terrace portion more uniformly. In crossing terraces at acute angles, the one-horse type gave more uniform cultivation.

C. B. WILLIAMS,

Head, Department of Agronomy.

RESEARCH IN ANIMAL HUSBANDRY

BEEF CATTLE, SHEEP AND SWINE INVESTIGATIONS

EARL H. HOSTETTLER, *in Charge*

The research program, for which I am responsible, has been expanded during the past year to include beef cattle and sheep work in addition to that which is being done with swine.

Mr. R. E. Nance has assisted with the experimental work throughout the year, in addition to his class-room duties, while Mr. J. E. Foster was appointed January 1, 1928, as full time assistant in research.

One or more problems with beef cattle, sheep or swine is being studied on each of the six Branch Stations in the State, and at the Swine Research farm, the College swine farm, and the Central Experiment Station farm at Raleigh.

The swine work at the Upper Coastal Plain Station in Edgecombe County has been decreased in order that certain land and equipment, allotted to livestock, might be used for problems with sheep.

This Station is cooperating with other State Experiment Stations and the Bureau of Animal Industry in the Quality of Meat work with beef cattle and in the Soft Pork problem with swine.

The projects, together with the object, plan and record of each, are listed according to their location in the following pages of this report.

SWINE RESEARCH FARM

Earl H. Hostettler and J. O. Halverson.

SOFT PORK

OBJECT: To produce commercially hard hogs from pigs of 35 and 60 pounds initial weight that have been finished on corn and cottonseed meal (6:1) after having been previously fed peanuts.

PLAN: The Soft Pork work was divided into two parts again this year, namely: individual and group feeding. The pigs that were fed individually were divided into four groups of three pigs each, as follows:

(a) Pigs of 35 pounds initial weight were fed a peanut ration until they attained a weight of approximately 80 pounds.

They were then finished on a corn and cottonseed meal ration and slaughtered at an average weight of approximately 240 pounds.

(b) Pigs of 60 pounds initial weight were fed the same rations as in (a), but were changed to the corn and cottonseed meal ration (hardening ration) at an average weight of 106 pounds and finished and slaughtered when weighing 237 pounds.

(c) The pigs in this group were started on a peanut ration to which 14 per cent of cottonseed meal had been added. Their average initial

weight was 59 pounds. They were changed to the hardening ration at 92 pounds, and finished and slaughtered at an average weight of 210 pounds.

(d) The three 60-pound pigs in this group were fed the peanut ration until they had attained an average weight of 101 pounds. Each pig was then put on a very limited ration and required to lose 20 to 25 per cent of its weight before being changed to the hardening ration. They were finished and slaughtered at an average weight of 214 pounds.



Pigs finished on grain, orchard grass pasture and a limited supply of protein supplements.

The group feeding consisted of two lots of six pigs each. The pigs in lot 1 were started on the peanut ration at an average weight of 36 pounds, changed to the hardening ration when weighing 82 pounds, and were finished and slaughtered at 229 pounds. The six pigs in lot 2 were fed the same rations as those in lot 1, but had average initial weights of 61 pounds, change weights of 97 pounds, and finish and slaughter weights of 219 pounds.

RECORD: Twenty-four pigs were fed according to the above plan and they were all shipped to Beltsville, Md., for slaughter at the close of the finishing (hardening) period. The results obtained from the physical grading of the carcasses and from the chemical analysis of the back fat indicate that there is considerable promise in this method of finishing hogs that have been fed peanuts.

VALUE OF PERMANENT PASTURE FOR FATTENING PIGS

OBJECT: (a) To determine if pigs grazed on permanent pasture will consume less concentrates than those in a dry lot when both are full fed the same grain mixture.

(b) To determine if a permanent pasture will replace 50 per cent of the nitrogenous feeds in the grain ration.

PLAN: Forty-five spring farrowed pigs with average initial weights of 42 pounds were divided into three equal groups and started on feed May 30, 1927. A mixture of corn meal, wheat shorts, fish meal, and mineral was fed the pigs in each group, the proportion of the different feeds being decreased so as to lower the content of protein in the ration as the pigs increased in weight. Group 1 and 2 were full fed on identical rations, but Group 1 was confined in a dry lot, while Group 2 was allowed to graze on orchard grass pasture. Group 3 was also grazed on orchard grass pasture and was full fed a grain ration containing only one-half as much of the wheat shorts and fish meal as had been added to the rations of lots 1 and 2.

RECORD: The results on this first year's work were rather unsatisfactory since five pigs from lot 1, three from lot 2, and four from lot 3 died during the progress of the experiment. Therefore, the remaining pigs in lots 2 and 3 did not consume enough of pasture to make possible any definite measure of the amount consumed since each of these two groups was allowed one acre of pasture.

The pigs in lot 1 consumed 362 pounds of feed for each one hundred pounds gain, but made an average daily gain of only 1.23 pounds, while those in lots 2 and 3 required 363 and 375 pounds, and gained 1.25 and 1.20 pounds daily in the order named.

COST OF RAISING PIGS TO WEANING TIME

OBJECT: To determine the cost of producing pigs to weaning age, or to eight weeks old.

PLAN: An accurate record has been kept of the amount and cost of the feed used for each sow from the time she was bred until her litter was weaned. The weight of each sow has been recorded at breeding, at farrowing, and when the litter was weaned. Individual weights of the pigs were taken at farrowing and at weaning time.

RECORD: A bulletin covering several years work on this project is being prepared and a summary of the complete findings should be ready for distribution in a short while.

COTTONSEED MEAL FOR FATTENING PIGS

R. E. NANCE, *Assistant in Swine Investigations*

OBJECT: To study the effect and cost of feeding an equal mixture of cottonseed meal and fish meal as the protein supplement for fattening pigs.

PLAN: One hundred and forty-eight 100-pound pigs were purchased in Eastern North Carolina for this work. They were divided into two groups and fed as follows:

Lot 1 received shelled corn, fish meal, and mineral; and lot 2 received shelled corn, one-half fish meal and one-half cottonseed meal, and mineral. Both lots were self-fed free choice.

RECORD: The gain, feed consumption, and cost were very similar in the two different lots. It is significant, however, that 26 of the pigs in lot 2 were fed the protein supplement containing cottonseed meal continuously for 153 days without showing any bad results therefrom.

WHALE MEAL AS A SUPPLEMENT TO CORN FOR FATTENING PIGS

OBJECT: To compare whale meal with fish meal as a protein supplement to corn for fattening pigs.

PLAN: Sixteen 100-pound pigs were divided into two equal groups and received their feed free choice from self-feeders. Shelled corn and mineral were common to both groups, but in lot 1 fish meal was used as the protein supplement, while in lot 2 whale meal was supplied.

RECORD: There was a very marked contrast in the results secured from these two feeds. The pigs in lot 1 receiving fish meal made an average daily gain of 2.04 pounds, while those receiving whale meal gained only 1.28 pounds per day on the average. Nearly 100 pounds less feed was required in lot 1 to produce 100 pounds gain, and the cost was \$1.74 less than in lot 2.

It was also noted that while each group consumed approximately the same amount of protein, the pigs in lot 2 consumed 3.7 times as much mineral as those in lot 1, but ate 153 pounds less corn per pig.

CENTRAL STATION FARM

J. E. FOSTER, *Assistant in Sheep Investigations*

UPGRADING OF NATIVE EASTERN NORTH CAROLINA SHEEP

OBJECT: To determine the rate of response of Eastern North Carolina ewes (native) to pure bred rams from the standpoint of mutton and wool production.

PLAN: Six native ewes from Eastern North Carolina were bred to a pure bred Shropshire ram in the fall of 1927. Pastures were used in so far as possible as a basis of maintenance.

RECORD: Five of the six ewes bred, dropped and raised a single lamb each.

From the comparisons of the weights and conformations of the ewes and their lambs at shearing time and again at weaning time, it was easily apparent that considerable improvement had taken place.

WINTERING EWE LAMBS RETAINED AS YEARLINGS FOR
BREEDING THE FOLLOWING YEAR

OBJECT: To determine the feeds best adapted for wintering ewe lambs to be fed for early lamb production the following season. In making this determination economy of wintering, efficiency of the feeds for maintaining flesh, and the effect on future usefulness were kept in mind.

PLAN: In the fall of 1927 the flock was divided into three equal groups of eight ewes each, and fed as follows:

Not No. 1—Alfalfa hay.

Lot No. 2—Soybean hay.

Lot No. 3—Cottonseed meal, cracked corn, and winter pasture.

RECORD: All three lots came through to January 1st in good condition, and there was very little difference in the weights of the three lots. Experiment closed in January on account of lambing.

BLACKLAND BRANCH STATION

SOYBEAN OIL MEAL FOR FATTENING PIGS

OBJECT: To study the cost and rapidity of gains on fattening pigs when a vegetable protein (soybean oil meal) is used in part to supplement the basal ration of corn.

PLAN: Fifty-eight 100-pound pigs were divided into two equal lots and were self-fed free choice for 67 days. Both groups received shelled corn and mineral, but lot 1 received fish meal alone as the protein supplement, while a mixture of equal parts by weight of fish meal and soybean oil meal was used to furnish the protein in lot 2.

RECORD: The results of this work are shown in full in Experiment Station Bulletin No. 259, under Table VIII.

COMPARISON OF PROTEIN SUPPLEMENTS AND MINERALS
FOR FATTENING PIGS

OBJECT: To study the effect of different substances added to the normal fattening ration in an effort to ascertain the cause and to minimize the losses heretofore incurred.

PLAN: Sixty fall farrowed pigs were put in dry lots and divided into four equal groups of fifteen pigs each on January 25, 1928. Each group was self-fed free choice, as follows:

Group 1—Corn, fish meal and mineral.

Group 2—Corn, fish meal and mineral.

Group 3—Corn, fish meal $\frac{3}{4}$, ground soybean hay $\frac{1}{4}$, and mineral.

Group 4—Corn, fish meal $\frac{3}{4}$, ground alfalfa hay $\frac{1}{4}$, and mineral.

The mineral mixture in all lots was composed of 10 pounds of ground limestone, 10 pounds of superphosphate, and 2 pounds of salt. However, in lot 2 calcitic limestone was used, while lots 1, 3 and 4 received dolomitic limestone in their mineral.

RECORD: All four groups made rapid gains on normal amounts of feed, but the pigs in Groups 2 and 4 did better than those in Groups 1 and 3. A brief summary of the results shows the following:

| Lot Number | Average Daily Gain | Feed per Cwt. Gain | Cost per Cwt. Gain | Profit per Pig Over Feed Cost |
|------------|--------------------------|-----------------------|-----------------------|-------------------------------------|
| 1..... | 2.36 | 371 | \$5.94 | \$3.09 |
| 2..... | 2.54 | 356 | 5.67 | 3.73 |
| 3..... | 2.31 | 391 | 6.29 | 2.57 |
| 4..... | 2.40 | 368 | 5.92 | 3.18 |



Native cows and purebred Hereford bull used in Quality of Meat experiment.



Reed growth on which cattle were grazed during the summer and fall.

HOGGING DOWN CORN

OBJECT: To determine the amount of gain that can be produced from an acre of standing corn when supplemented with protein and mineral.

PLAN: Sixty-six fall farrowed pigs having average initial weights of 41 pounds were allowed to hog down three acres of standing corn. They were furnished fish meal and mineral in separate compartments of a self-feeder during the 32 days that they remained in the field. The yield of corn was estimated as 29.7 bushels per acre and each acre produced 640 pounds of pork, or a profit per acre of 33.45 with corn at 75 cents per bushel and hogs at 10 cents per pound.

QUALITY OF MEAT STUDIES WITH BEEF CATTLE

OBJECT: To make studies of (a) calves that have been produced from native cows bred to a native bull, and (b) calves that have been produced from native cows and bred to a pure bred Hereford bull. These studies to be made of the live animals during the growth and fattening periods, of the carcasses at time of slaughter, and of the meat through laboratory, cooking and palatability studies.

PLAN: Thirty-two native eastern cows were divided into equal groups of 16 cows each. A pure bred bull was put with Group 1, and a native bull, of similar appearance and conformation to the cows, was put with Group 2. These two groups will be kept separate at all times in order that none of the cows will be bred to other than their designated bull. Due to lack of tame permanent pastures, all cattle will be grazed on reed pasture throughout the grazing season, each group being confined in an area of approximately 100 acres.

RECORD: None of the calves that were produced are old enough to go into the feed lot. Therefore, no results are available as yet.

UPPER COASTAL PLAIN BRANCH STATION

HOGGING DOWN IMMATURE CORN

OBJECT: To determine the amount of gain that can be produced from early maturing corn, if the pigs are turned into the field, when it is in the dough stage.

PLAN: Sixty-six spring farrowed pigs were used to harvest 11.85 acres of corn. They were turned into the field on July 20 when the corn was in the dough stage. Fish meal and mineral were kept in separate compartments of a self-feeder and were available to these pigs while they were "hogging down" the corn.

RECORD: One acre of corn, 48 pounds of fish meal, and 7.6 pounds of mineral were required to produce 283 pounds of gain.

A STUDY OF THE UTILIZATION OF CROPS, GROWN IN ROTATION, BY TWO DIFFERENT METHODS

(Animal Industry and Agronomy Departments Coöperating)

OBJECT: A comparison of crop yields, financial returns, and soil texture under two methods of utilizing the crops in a three-year rotation with cotton.

(1) By hogging off all crops except cotton. (2) By harvesting certain crops and turning under cover crops and crop residues.

PLAN: Three acres uniform in topography, soil type, and fertility were selected for this work. They were divided into three fields of one acre each and seeded to corn this first year. The second year they will all be seeded to cotton, and the third year to soybeans. The crops, except cotton, from two of the fields, will be hogged off while those from the third field will be harvested and weighed. The same kind and amounts of fertilizer will be used in all three fields the first year, but thereafter 80 per cent of the fertilizing value of the supplementary feeds that are fed to the pigs in one of the fields will be deducted from the next application.

RECORD: The two acres of corn that were "hogged down" produced 740 pounds gain on eight pigs with the addition of 241 pounds of fish meal and 77 pounds of mineral. The one acre that was harvested and weighed produced 1,710 pounds of corn in the shuck.

ESTABLISHMENT OF A FARM FLOCK OF SHEEP

OBJECT: To establish a high grade farm flock so that breeding, feeding, and management data can be gathered for the producers of sheep in this section of the State.

PLAN: Nine grade ewes, a pure bred Dorset ram, and four grade Dorset ewe lambs were purchased in the summer of 1928. The entire flock was drenched a few days before being moved to the farm. It was also dipped upon arrival at the farm. The plan is to gradually build up this flock to one of high grade Dorset breeding through the continued use of pure bred Dorset rams. During the grading-up process the sheep will be kept under the conditions most favorable and economical for that section of the State, and breeding, feeding and management data will be gathered.

When the flock contains sufficient Dorset blood to insure early mating, some work with "hot house" lamb production will be begun. It is also hoped that within a short time a few pure bred Dorset ewes may be secured so that pure bred rams can be furnished to nearby breeders.

RECORD: The experiment has been going on too short a time to draw any conclusions, but the flock is doing nicely and the four ewe lambs, which were sired by the Dorset ram show considerable improvement over the old grade ewes.

PIEDMONT BRANCH STATION

CONTROL OF STOMACH WORMS IN SHEEP BY DRENCHING

OBJECT: To control stomach worms in lambs by drenching.

PLAN: Ten ewe lambs were divided into two equal groups and cared for in the same way except that one group was drenched with the bluestone solution monthly from August 1, 1927, to November 12, 1927.

RECORD: The lambs in the drenched lot made more gain than the ones in the undrenched lot and were in a more thrifty condition at the close of the experiment.

THE FAMILY SOW

OBJECT: To determine the annual cost of maintaining two pure bred sows and one pure bred boar and their offspring under general farm conditions where all possible waste feeds are utilized. Also to promote "upgrading" by making available a pure bred boar to the community.

PLAN: Two or more pure bred sows and one pure bred boar have been maintained on each of four Branch Stations. The pigs have been utilized for meat on the different farms or sold in the community at weaning age. Any waste or unmarketable feeds have been used in feeding these hogs whenever possible.

RESULTS: Sufficient data have not been collected from which to draw definite conclusions. The three Branch Stations that are coöperating in this project, in addition to the Piedmont Station, are: Coastal Plain Station, at Willard; Mountain Station, at Swannanoa, and the Tobacco Station, at Oxford.

New Holland Corporation, Hyde County

The following project was carried on coöperatively with the above corporation by special arrangement:

VALUE OF *SCIRPUS AMERICANUS* ROOTS FOR FATTENING PIGS

OBJECT: To study the value of the roots and native grazing, indigenous to the Mattamuskeet Lake region, when supplemented with different amounts of grain, for fattening pigs.

PLAN: Thirty-two pigs averaging 85 pounds in weight were divided into four equal groups and fed as follows:

Group 1—A one per cent grain ration.

Group 2—A two per cent grain ration.

Group 3—A three per cent grain ration.

Group 4—A four per cent grain ration.

The percentage of the grain ration was based on the live weight of pigs in the different groups, the amount being changed at 14-day intervals when the pigs were weighed. In addition to the grain ration each group had access to five acres of land that was well sodded with sword grass.

RESULTS: The results secured from this one trial would indicate that the roots were of very little value for fattening pigs, since the pigs receiving the most grain consumed very few of the roots. As the percentage of grain in the ration was increased, the amount and cost of feed to produce 100 pounds gain decreased and the rate of gain increased.

NUTRITION INVESTIGATIONS

J. O. HALVERSON, *in Charge*

1. Soft Pork Project in Cooperation with E. H. Hostetler, Swine Husbandry.

Results are satisfactory and promising. All fat samples, 48, have been analyzed and the feed analysis is being completed. This project is reported in more detail under Swine Husbandry.

2. **Cottonseed Meal Feeding Studies** in Cooperation with R. S. Curtis and C. D. Grinnells.

Projects 1 and 3, Roughage Studies with C. S. Meal, were concluded in 1927; Project 2, on March 4, 1928.

The livers of 12 cows and 8 calves, and four feed samples have been biologically tested for the presence of Vitamin A. These studies are now being prepared for publication.

3. **Vitamin B Distribution** in the various structural parts of the Virginia Runner Peanut.

This work is a continuation of that reported with partial results for the year ending July 1, 1927. This project has been completed. Results are being prepared for publication.

4. (a) **Colony Ration Studies** with a Cereal Ration without cabbage and whole fresh milk. Ten per cent dried liver and 10 per cent meat residue (dried extracted meat muscle) were added. The third and fifth generations respectively, have been produced.

(b) **Reproductive Studies** with partially extracted fat-free peanuts are being continued. In an attempt to obtain good reproduction, *i. e.*, rearing of young, various modifications of the ration were used. With dried liver added to the ration, the third generation has been produced. This is the sixth generation in which peanuts furnish the bulk of the protein.

Published: The Status of the Cottonseed Meal Injury Problem. Journal Oil and Fat Industries, pp. 109-113. April, 1928.

DAIRY INVESTIGATIONS

C. D. GRINNELLS, *in Charge*

Dairy investigations are carried on at the Central Experiment Station at Raleigh, the Coastal Plain Branch Station at Willard, and the Mountain Branch Station at Swannonoa.

In addition, one project dealing with Bovine Infectious Abortion in dairy cattle is carried in cooperation with the Veterinary Division of the North Carolina Department of Agriculture and twenty-five dairymen of the State.

CENTRAL EXPERIMENT STATION DAIRY

DAIRY CATTLE PASTURE MANAGEMENT STUDIES I

Pasture management, its relation to yield, and to length of life of our tame grass pastures, is of much importance in building a permanent dairy husbandry. This study is directed especially at the factors which affect the early life of the pasture.

An attempt will be made to evaluate the following systems of management:

Plat I. By subjecting one three-acre plat to normal grazing. Normal grazing is assumed to be enough animals to graze the plat clean and yet maintain a good sod.

Plat II. The second three-acre plat is being heavily grazed. Heavy grazing is taken to be normal grazing plus 25 per cent more cow days.

The results of the two systems of management will be studied during the second, third and fourth years.

Both plats have been grazed since July as outlined.

Plat II has been grazed about as close as possible with cattle, perhaps too close to get the best results under practical conditions.

Plat I does not appear to be over-grazed as there is a much larger and more vigorous turf. This plat also carries a greater number of dead weed stems, indicating that heavy grazing has a tendency to control weed growth.

This project is conducted in coöperation with the Agronomy Division.

BOVINE INFECTIOUS ABORTION

Bovine Infectious Abortion is the most important disease confronting the dairy interests of this State. This project is to work out the most satisfactory methods of control and eradication under practical farm conditions as they exist in this State. It has been in progress for eighteen months. Twenty-five herds are included in the study, and nine of them have passed one or more clean tests. In seven herds the disease appears to be under control. The data to date indicates that every herd is a problem in itself and the control must be worked out in a way to get the most direct and efficient application.

In pursuing this work the following difficulties have hindered progress in the direction of clean herds:

1. Lack of consistent coöperation in carrying out instructions in regard to segregation and sanitation.

2. The average individual places too much confidence in one test and does not pay enough attention to the time of test and to the reactions of the remainder of the herd from which the new animal is taken.

This project is conducted in coöperation with the Veterinary Division of the North Carolina Department of Agriculture.

CALF FEEDING STUDIES

This study is to determine the difference in cost and efficiency of powdered skim milk and a standard calf meal. To date two groups of three calves each have been fed. The powdered skim milk group were more thrifty and made a much better growth. The data is not complete enough to draw conclusions as to the efficiency of the two materials when cost is considered.

This project is being continued.

COASTAL PLAINS BRANCH EXPERIMENT STATION

The dairy herd at this station has made progress in the way of improvement in type and uniformity during the past year. The daughters of Distinguished Eminent that have freshened are giving a good account of themselves, and a number of them are now on official test.

The experimental work in feeding is under much of a handicap on account of inadequate equipment in the way of buildings.

DAIRY HERD DEVELOPMENT

The data on the project shows two additional lactations on Eminent 19th's daughters. This will complete the study of Eminent's daughters. Eminent's granddaughters or the daughters of Rumina's King are showing ability to

produce equal to, if not better than their dams. Rumina's King is now a Silver Medal bull with two Gold Medal daughters. The granddaughters of Rumina's King, or the daughters of The Distinguished Eminent are making good records. This shows a continuance of good production as a result of selection of young, unproven sires, with pedigrees which indicate ability to produce.

HERD AVERAGES

| | Milk | Test | Butter-fat |
|-----------|-------|------|------------|
| 1927..... | 6,005 | 5.42 | 311.7 |

REGISTER OF MERIT RECORDS

| | | | |
|------------------------------|---------|----------|--------------|
| Eminent's Field Flower..... | 563,000 | Class AA | 716.7 B. F. |
| Eminent's Fern Lucile..... | 562,998 | Class AA | 710.1 B. F. |
| Eminent's Queen Betty..... | 562,994 | Class A | 669.7 B. F. |
| Eminent's Noble Duchess..... | 562,992 | Class AA | 535.03 B. F. |

DAIRY CATTLE FEEDING STUDIES

The feeding trials, comparing simple and complex mixtures for economical milk production, were continued during the winter of 1927-1928. The double reversal method of feeding was used. The simple home mixture produced equally as good results as the complex mixture. The consumption of hay was greater when the complex mixture was fed.

The results per 100 pounds of concentrate mixture are as follows:

| Simple Mixture | Complex Mixture | Corn Silage | Alfalfa Hay | Milk Pounds | Fat Pounds |
|----------------|-----------------|-------------|-------------|-------------|--------------|
| 100 | 100 | 288 280 | 95 108 | 254 261 | 12.5 12.5 |

This work will be repeated.

FARM DAIRY REFRIGERATION

This is collected data on a project with an electric dairy cooler operated under average farm conditions. The data is being assembled to get an idea of the cost of operation and efficiency of this type of cooler in the Coastal Plains section. The cost of current to operate this cooler during the year varied from \$4.87 for the month of February, to \$32 for the month of June, with an average monthly current consumption of 148 kilowatt hours and an average monthly cost of \$18.57.

A study of the data on bacterial counts of market milk at the point of delivery is interesting. Before installation of the electric cooler in December,

1926, the average monthly bacterial count was 64,000 per c.c., while in 1927 it was 21,000 per cc., and during 1928 it was 14,000 per cc. In this case the data indicates a more efficient cooling as well as storage.

This project is conducted in coöperation with W. L. Clevenger, of the Dairy Manufacturing Section.

MOUNTAIN BRANCH EXPERIMENT STATION

HERD IMPROVEMENT

The herd at this station is made up largely of young heifers sired by Sybil's Gamboge of Swannanoa. This sire is well bred for production and his daughters appear to be of the milky-kind.

Swannanoa's Meridale Fox 288998, a son of Oakwood D's Fox, and out of Meridale Prince's Nellie 393577, a Gold Medal cow, has been added to this herd as a Junior herd sire.

The daughters of Eminent 19th have completed their lactations in this herd. A number of lactation periods have also been added by the daughters of Rumina's King.

HERD AVERAGES

| | Milk | Per Cent | Butter-fat |
|------|-------|----------|------------|
| 1927 | 7,479 | 4.97 | 360.3 |

REGISTER OF MERIT RECORDS

| | | | |
|----------------------------|---------|-----------|--------------|
| Eminent Lass Beauty | 577,892 | Class AAA | 450.03 B. F. |
| Majesty's King Lass | 649,114 | Class AAA | 379.47 B. F. |
| Majesty's Eminent's Evelyn | 649,111 | Class AAA | 403.00 B. F. |
| Eminent's Foxy Eva | 562,990 | Class AAA | 515.19 B. F. |

DAIRY CATTLE FEEDING STUDIES

This is a comparison of simple and complex mixtures under commercial herd conditions. The double reversal method of feeding was used. The simple mixture of four constituents gave almost as good results as the more complex mixture, thus confirming the results of the previous year. The consumption of silage and hay was practically the same with both mixtures.

| Simple Mixture | Complex Mixture | Corn Silage | Alfalfa Hay | Milk Pounds | Fat Pounds |
|----------------|-----------------|-------------|-------------|-------------|------------|
| 100 | 100 | 247 | 95 | 286.7 | 14.05 |
| | | 247 | 93 | 297.0 | 14.20 |

This work will be continued.

R. H. RUFFNER,
Head, Animal Husbandry Department.

RESEARCH IN BOTANY

Division of Plant Pathology

S. G. LEHMAN, in Charge

SOYBEAN DISEASES

The greater portion of the time devoted to the work of this project has been spent on studies of three soybean diseases: frogeye, mildew, and bacterial postule.

Frogeye Leaf Spot. Much of the information gleaned from the study of frogeye leaf spot has appeared in the Journal of Agricultural Research, Vol. 36, pp. 811-831, under the title, "Frogeye Leaf Spot of Soybean Caused by *Cercospora diazu Miura*." Certain additional information has been secured since the above-mentioned paper was sent to press. It has been determined that the fungus which causes frogeye may remain alive on diseased leaves until the succeeding planting season. This happens when the diseased leaves are kept moist and yet sufficiently well protected to prevent extensive decay. On the other hand, the frogeye fungus is apparently unable to survive the influences of strong disintegration which occurs when diseased leaf tissue is in contact with moist soil. These observations seem to make safe the conclusion that the plowing under of infected leaves and stems will cause the death of the frogeye leaf spot fungus and thus prevent the carry-over of this disease in such material.

As another phase of the studies on the frogeye disease, a large number of fungicides were used in an effort to control the disease by seed treatment. A few of these were applied as liquid, more of them as dusts. None of the materials used gave satisfactory control. The disease appeared as early and developed as destructively in the plots planted with treated seed as in the check plots planted from untreated seed. Apparently the fungus penetrates the seed coat and thus lives internally from season to season. However, there is still the possibility that it is being perpetuated on some weed host.

Tests were made to determine if the frogeye disease can be controlled by use of seed two years old. Accordingly, seed of two varieties, Laredo and Otootán, were planted in the second season after they had been harvested. Frogeye developed on the plants grown from these two-year-old seed, while nearby plants which had come from disease-free seed of the same varieties developed no disease. The severity of the disease on the plants grown from the two-year-old seed was estimated to be about one-fourth of that on plants grown from one-year-old seed. Apparently a considerable proportion of the fungus carried in the seed from diseased plants dies before the second planting season after harvest.

Mildew. Certain varieties of soybeans, particularly Herman and Laredo, are strongly susceptible to downy mildew. (*Peronospora manshurica*.) A test was made to determine the value of seed treatment in the control of this disease. Seed of the Herman variety was used. These seed had come from a

field in which 50 to 75 per cent of the plants were infected with mildew in the previous season. Different lots of these seed were treated with solutions of mercuric chloride, semesan, and uspulun, while some of the seed were planted untreated for comparison. At the height of the growing season mildew was found to be present on 50 per cent of the leaves of the plants grown from untreated seed, while on the plants growing from treated seed the percentage of infected leaves varied from a minimum of 1 to a maximum of 10. The treatment with semesan and uspulun were slightly more effective than with mercuric chloride.

Bacterial Pustule. The bacterial pustule disease (*B. phaseoli* var. *sojense*) is widespread in this State and occurs more or less abundantly in practically every field of soybeans. In the severe form of this disease large areas of leaf tissue are killed and the value of the plant as a producer of seed and forage is greatly diminished. A test was made to determine the effectiveness of seed treatment in the control of this disease. Various organic mercury compounds were used, most of them as dusts, but some of them as solutions. None of these disinfectants gave satisfactory control of bacterial pustule. In the early part of the season fewer plants were found diseased on the treated rows than on the check rows, but by the end of the growing season bacterial pustule had spread to such an extent that 95 per cent of the leaves on the treated rows were infected. The treatments served to delay the time when the disease became general and thus may have yielded some advantage to the treated seed.

Tests were also made to determine if the bacteria which cause bacterial pustule survive the winter in leaves of diseased plants. Diseased leaves were gathered from the field in September and stored in a dry place until July of the following season. At this time they were macerated in water in order to free any bacteria that might be alive in them, and then were used to inoculate soybean plants growing in the greenhouse. The bacterial pustule disease developed on every plant inoculated in this way. In a similar test diseased leaves were placed out of doors in April where they would keep moist and be subjected to weathering and decay. Plants inoculated with this partially decayed leaf material in the following July developed the pustule disease. Thus it is evident that leaves from diseased plants serve as a source of inoculation for bacterial pustule.

As a part of the studies on control of the bacterial pustule disease, two tests were run to determine if any of the numerous varieties of soybean are immune. One of these tests was conducted in the greenhouse during the winter, and the other in the field during the natural growing season for soybeans. In the greenhouse tests 44 varieties were grown, and in the field test 57 varieties were employed. In each test the plants of the different varieties were artificially inoculated several times at intervals of a week or ten days during their growing period. The inoculations were made by spraying upon the plants pure cultures of the bacterium which causes bacterial pustule. The inoculated plants were examined from time to time and the amount of disease determined for each variety. Of all the varieties tested, Columbia proved to be the most resistant. In this variety only 2 out of 23 plants inoculated showed any disease, and on these two plants the disease was represented

by very few lesions. As judged by these two tests, this variety possesses a degree of resistance amounting to practical immunity.

The varieties most susceptible to injury are: Yokotan, Pine Dell Prolific, Virginia, Herman, Dixie, Hollybrook, Merko, Hoosier, Midwest. Among the varieties least susceptible to injury are, in addition to Columbia named above, the Laredo, Ootootan, Tar Heel Black, and Easy Cook varieties. Mammoth Yellow and Biloxi may be regarded as intermediate in point of injury resulting from this disease; however, considerable injury has been observed at times on these varieties in the field. Whenever possible seed of these varieties for planting should be obtained from disease-free fields. On farms where the bacterial pustule disease causes serious damage to the soybeans commonly grown, the variety Columbia may be used to avoid this loss.

COTTON SEED TREATMENTS

One of the factors contributing to high yields of cotton is early planting. This factor has come to assume special importance since the advent of the boll weevil. Early planting, however, increases the risk of a poor stand, and nearly every cotton planter has repeatedly faced the problem of contenting himself with a poor stand or going to the added labor and expense of re-planting. The greater portion of the reduction in stand of early planted as compared with later planted cotton is due to the killing of the seedlings by one or both of two fungi, namely, the anthracnose fungus (*Glomerella gossypii*), and the sore shin fungus (*Rhizoctonia sp.*).

The anthracnose fungus is carried in the form of spores on the surface of the cotton seed and attacks the cotton seedling at the time of germination. If weather conditions shortly after planting become unfavorable for growth of cotton seedlings, many of them are killed.

The sore shin fungus is widely distributed in all cultivated soils. Under the conditions of temperature and moisture which frequently prevail at the time of early planting of cotton, great numbers of the seeds are attacked by the sore shin fungus and killed before germination is fairly begun. Others are killed between the time of beginning germination and breaking through the soil, and many more damp off when but two or three inches tall.

With these losses in mind, tests have been undertaken in order to determine if seed treatment will not correct them in part at least. It was thought that the application of a coating of disinfecting dust to the surface of the cotton seed before planting would prevent killing many of the seeds and seedlings, and thus a more nearly perfect stand might be obtained. Different lots of cotton seed of the same variety were dusted before planting with a number of disinfecting materials such as mercuric chloride, copper carbonate, formaldehyde, and several proprietary products containing mercury in combination with phenol and its derivatives.

The results of these tests are highly encouraging. In one field a careful count was made of the seedlings on the treated and untreated rows. Here the least effective treatment resulted in an increase of 95 per cent in number of seedlings, while the most effective treatment increased the stand by 355 per cent. The average increase of stand in all treated rows over all untreated check rows was 146 per cent. In still another field in which the stand on the rows planted to treated seed was estimated to be "fair," the untreated portion of the

field had to be replanted. It is now believed that the use of these disinfecting dusts on cotton seed will in many cases give sufficient protection to enable the grower to plant his seed from a week to ten days earlier than would otherwise be safe. Supplementary experiments are being made in inoculated soil in the greenhouse. These tests will aid in narrowing our selection of dusting materials to the few of greatest merit. These will then be used in field tests next season.

WHEAT RUST

The work on this project is being done coöperatively with the office of Cereal Investigations of the U. S. Department of Agriculture and the Department of Agronomy at this station. At the Mountain Branch Station near Swannanoa nurseries containing about 150 varieties and selections of wheat were sown both on upland and lowland. Leaf rust came so late and in such meagre amount that no data bearing on relative rust resistance were obtained. However, some interesting data bearing on the ability of the different selections to resist winter injury were secured. On many of the varieties actual count was made of the number of heads per rod row and was estimated on all the other varieties. Yield of the different varieties was also determined. Varieties such as Leaps' Prolific, Purple Straw, Alabama Blue Stem, Gleason, and Fulcaster were badly damaged, while selections from crosses of these varieties with Kanred, and other closely related western wheats showed comparatively little winter killing. It is possible that much of the loss which occasionally results from winter killing in this State might be avoided by use of high yielding selections from crosses between our commonly grown wheats and some of the more hardy western varieties. Many of these crosses are not only resistant to winter injury, but also possess a relatively high degree to resistance to leaf rust and stem rust.

As another phase of the wheat rust work an attempt was made to determine the value of sulphur as a means of controlling this disease. This work was done on the Central Station Farm at Raleigh with sulphur. The material was applied with a hand cotton duster and all applications were made in the early morning while the plants were wet with dew. The test was so planned that certain plots received one, two, or three applications of sulphur per week, and the total number of applications per plot per season was made to vary from 1 to 13. There was also a variation in respect to the date on which the applications were made. Certain plots received only one, two, or three applications, and these were made early in the season, while on other plots a like number of applications was made late in the season.

Rust appeared late at Raleigh and the infestation was considerably lighter than for the average season. Under these conditions good control of leaf rust was obtained on all plots except those receiving only early applications. Plots which received only one application of sulphur per week carried no more leaf rust than plots which were dusted two or three times per week. The results indicate that two successive applications, one made about April 30 and another about May 7, would have given as good control as more numerous applications. This test indicates that leaf rust injury to wheat may be considerably reduced by use of dusting sulphur. Further tests will be necessary in order to determine if this will be profitable when increase of yield is balanced against the cost of dusting materials and the labor of application.

SWEET POTATO DISEASES

R. F. POOLE, *in Charge*

In Storage and Transit with Reference to their Control with Chemical Treatment. Results of studying the distribution of storage diseases in banks, show that black rot caused by *Ceratostomella fimbriatum* is of greatest importance. Rots caused by *Fusarium* species *Sclerotium bataticola* and *Diplodia tubericola* are of minor importance, but were sometimes the cause of heavy loss. Contrary to a popular belief and information on activities of *Rhizopus nigricans* causal organisms of soft and ring rots, these studies indicate that the disease is of little economic importance in the bank, but does cause the greatest loss to potatoes in storage houses, in transit, and before being consumed.

Further studies in banks and in storage houses were carried out this year. Black, soft and surface rots were reduced with lime in both liquid and dust forms. Bordeaux mixture 20-20-50 also reduced losses caused by the storage rots. Copper sulphate used alone caused shrinkage and injury in which the cork tissues were destroyed. Neither Bordeaux nor lime in either liquid or dust applications caused any shrinkage or surface injury. When these chemicals were applied after the potatoes were stored for some time, they were much less effective than when applied immediately after harvest. It was further shown that the treatments had to be carried out thoroughly, since lime sprinkled over potatoes in either banks or in houses was not effective.

Causal Organisms. The *Fusarium vasinfectum*, *F. conglutinans*, *F. lycopersici*, and *F. batatatis* causal organisms of cotton and cow pea, cabbages, tomatoes, and sweet potatoes, respectively, were isolated from diseased plants on nearby areas, and pure lined for further study. The wilts of cotton, cow-pea, and cabbages were more severe than sweet potato and tomato this year, but less severe in the same areas during 1927, which indicates that the diseases are not due to the same species of *Fusaria*, nor are they of equal severity under similar conditions.

In studying the characteristics of plants of varieties susceptible to and those resistant to *Fusarium batatatis* it was found that the diameter of the stem of the Nancy Hall, a very susceptible variety, is greater than that of the Red Brazil and Triumph, two resistant varieties, but the stems of the susceptible Porto Rico and Yellow Jersey varieties are the same as that of the Triumph variety. The number of roots on plants of different varieties vary, but the variation is found on both susceptible and resistant varieties. Even the arrangement of the roots on the stem varies, but is seen alike on both susceptible and resistant varieties. One outstanding difference in the character of susceptible and resistant varieties was noted in sprouting and in growth of the plants in the field. The varieties showing greater sprouting activity and quick response to field growth are most resistant to stem rot. The disease was obtained equally as well when microconidia, macroconidia, and mycelium were used for the inoculum.

Infection was previously reported as taking place through the open bundles, which occurred in the natural removal of sprout from the mother potato,

and through injured areas on the stem. This was confirmed in tests conducted this year in which the inoculation studies were conducted with sprouts and vine cuttings.

Small rootlets on the sides and ends of the potato were found to harbor *Fusarium batatatis*. It was heretofore considered to live over in the bundles only. It not only lives over, but develops on the potato in storage.

Limiting Factors of Fungus Growth. Cultural studies with *Fusarium batatatis*, the causal organism of stem rot, wilt, yellows, or rot root, show that carbohydrates are the limiting factor of growth. Polysaccharides, monosaccharides and disaccharides are readily utilized in the growth of the fungus. Excellent growth was obtained on cooked and raw grass, barnyard manure, and sweet potato stems. The readiness and vigor that this organism attacks the dead organic matter may account for its longevity on many soils where crab grass develops in abundance and where it is rarely decomposed in a season.

Sweet potatoes grown on light sandy soil are more resistant to *Fusarium oxysporium*, the causal organism of surface rot, than those of the same variety grown in the same field on heavy soil. The difference is due to a variation in the process of curing, since potatoes grown on the light sandy soils were much less susceptible to injury and shrunk less than those from loamy soils.

When sweet potatoes were grown on soils which had received high amounts of potassium, nitrogen, calcium, sulphur, and phosphorous in the forms usually applied as commercial fertilizers, and were inoculated with *Ceratostomella fimbriatum*, *Rhizopus nigricans*, and *Monilochaetes infuscans* there was no difference in the time and severeness in which the diseases developed, yet there was a very great difference in yield where the different fertilizers were used.

Prevention of Field Infection of *Fusarium Batatatis*. A report on this project last year showed that the disease, stem rot, rot root, or yellows caused by *Fusarium batatatis* could be prevented by treating roots and stems with Bordeaux mixture, monohydrated copper lime dust, and to some extent with the organic mercury compounds. The report had to do with tests carried out in the greenhouse and in pots mostly. This year the tests were conducted in the field in various parts of the State where stem rot is known to occur. The tests were placed in Currituck County, where the Yellow Jersey is grown for early market, and in Cumberland, Richmond and Wake counties. Varieties used in the tests were Porto Rico, Yellow Jersey, Nancy Hall and Triumph. In conducting these tests plants were inoculated with a pure culture of *Fusarium batatatis*. Some were treated, others left untreated and set in the field. Others not inoculated were set with and without treatment.

The season was cool and soil moisture for the year was above normal, so that the amount of stem rot in the infected areas was not severe this year. On Newbern's farm in Currituck County, the natural infection was only 11.3 per cent and heavily inoculated plants on the same farm showed only 20 per cent infection. On Grover Sawyer's farm in the same county the natural infection was 3.2 per cent in comparison to 75 to 80 per cent loss the year previous on the same land. Artificial inoculation on this farm resulted in a 75.6 per cent infection and a 59.2 per cent kill. On the farm of A. H. Ragan, at New Hill, the natural infection was 8.8 per cent in comparison to an arti-

ficial infection of 95 per cent. Similar results were obtained on the Scarborough farm at Hoffman, the Beard farm at Cedar Creek, and the College farm at Raleigh.

Giving further consideration to stem and root treatment as described last year, excellent practical control was obtained on all of the farms given above this season. On the Newbern farm the infection of plants treated with 10-10-50 Bordeaux was 4 per cent in comparison with a 20 per cent infection of untreated plants. On Sawyer's farm the comparison was 8.4 per cent in comparison to 75.6 per cent. On Ragan's farm it was 6 per cent to 95 per cent. Greater control was obtained with 50-50-50 Bordeaux mixture, but this caused some injury. The greatest control without injury was obtained with a 20-20-50 Bordeaux. A monohydrated copper lime dust, 25 per cent copper sulphate and 75 per cent hydrated lime, controlled the disease without injury. The results with both dry and wet Bordeaux commend either for practical application. The dust treatment has some advantage in that it retained greater standardization than the liquid and was prepared well in advance of the time for treating. Chemicals, other than the copper compounds which were all somewhat effective, and combinations of chemicals, were tested. Some were not effective, while others caused injury.

Plants of susceptible Porto Rico and Yellow Jersey varieties were inoculated with *Fusarium batatas*, and after the stem rot disease was induced they were treated with 10-10-50, 20-20-50, and 50-50-50 Bordeaux mixture, but in no case was there any check in the disease. These results show that the plants must be healthy before the Bordeaux treatment will be effective.

Disinfection Studies. Two varieties of sweet potatoes, Nancy Hall and Yellow Jersey, slightly, moderately, and severely infected with Scurf were treated with disinfectants at various strengths and in dust and liquid forms. Formaldehyde 1-100 and potassium permanganate 3-100 used for 10, 20, 30 and 60 minutes did not control scurf, nor was there any reduction regardless of degree of infection. Mercuric chloride 1-1000 used for 10, 20 and 30 minutes controlled the disease when infection was slight, but not when the cortex was severely infected. The organic mercury compounds applied at the rate of 4 ounces per bushel controlled scurf, but caused definite retardation of sprouting which would prohibit their use in practice. Used as a dip these compounds were not effective. A 10-10-50 Bordeaux mixture and 25 per cent monohydrated copper lime dust reduced infection without causing a retardation in sprouting.

When disease-free potatoes were inoculated with spores of *Monilochaetes infuscans*, the causal organism of scurf, treated with disinfectants and bedded in the usual way for sprouts to develop, four ounces of a 6 per cent organic mercury dust gave complete control, but retarded the sprouting. Mercuric chloride 1-1000 held infection to 10 per cent. The dip methods of treatment with formaldehyde, phenoco, organic mercury and potassium permanganate were not effective in preventing the germination of spores and infection of the potato, sprout stems and roots.

When the cortex, on which scurf is confined, was cut away, the disease was completely controlled without retarding sprouting. When the infected tissues were treated with concentrated sulfuric acid, the fungus was killed with slight retardation of sprouting.

DEWBERRY DISEASE STUDIES

Brown spot caused by *Cercospora rubi* was severe this season and caused heavy defoliation before frost. The infection started on the first leaves and advanced outward, but did not cause complete defoliation at any time. The leaves nearest the end points were apparently carrying on the activities of the canes, since the growth was always in excess of the amount used for the crop, and on some plants two to three feet of canes were cut away when the plants were staked. An early 4-4-50 Bordeaux spray, August 20, reduced defoliation, but the results secured at picking indicate that treatment for this disease is not economical, since there was no difference in yield on sprayed and unsprayed plants. Furthermore, it is an autumn disease, and has not been observed any season previous to the first of July, at which time the leaf spot and cane blight caused by Brown spot were of minor importance.

Anthraxnose became severe during the latter part of June, and caused heavy loss on both sprayed and unsprayed plants. Weather conditions were very favorable for infection just before and during harvest. Bordeaux mixture applied June 15, three weeks before harvest reduced infection, but an undesirable deposit remained on the berries, indicating that such late applications may be detrimental to the sale value of the berries in seasons when the rainfall is low during the month previous to harvest.

Stem girdling caused by *Mycosphaerella rubi* was severe previous to tying up vines in March. This disease occurred during the autumn and winter seasons, and resulted in slight damage to canes and leaves during early spring, but it is of little economic importance at any time. The girdling is rarely seen on the oldest parts of the canes, but occurs near the extremes, where it is a natural aid to the separation of new and old plants.

Blighting of canes due to *Coniothyrium fukelii* is of greater importance than was determined heretofore. The infection in the principal dewberry growing area varies from 10 to 100 per cent. The fungus attacks the injured and pruned parts, and works downward into the old stubs left from pruning. When the tissues below new canes, which arise from the base of old canes, are killed, that part of the plant wilts. This happens during the productive period. Infection was found to occur soon after the plants were pruned the middle of July. Studies to date show that the disease is most severe on plants where canes have been pruned well above ground, and on plants where the soil was washed away from the canes. Where canes were pruned below the soil, there was no such pronounced fruiting of the organism or development of the disease on canes such as on exposed pruned areas.

The root rot caused by *Collybia dryophila* caused less damage to the crop than during the two previous seasons. The development of the plant during the autumn season, on which the next crop is produced, was judged above normal. While the same conditions may have favored the development of the organism, the results indicate that they were not. Further evidence was obtained that shows a ready dissemination of the fungus on plant sets. In an effort to treat plants for the control of the disease on transplants all substances, including a 4-4-50 Bordeaux mixture, caused injury. The soil treat-

ment experiments discussed last year have been continued. In studying the behavior and productivity of plants affected with the root rot, a few plants producing well and making vigorous growth have been found in areas where the disease is severe and uniformly distributed. There is some indication now that the plants represent resistant strains, since transplants from the more vigorous plants showed less disease than those from diseased plants.

RESEARCH OF TEACHING STAFF

B. W. WELLS, *in Charge*

THE SHRUB BOG PROJECT

Having made the preliminary survey of the Open Grounds (Purnell project in coöperation with the Bureau of Soils, U. S. Department of Agriculture), it would seem desirable to make a brief report at this time. This will be organized in accordance with the project outline previously submitted.

Composition of Present Vegetation. The ecological classification of the communities was made and probable successions noted. Plant lists were taken on which relative dominance was indicated by the 1-5 number method. In this connection it is of interest to note that *Cyrtilla racemiflora*, the wet bay indicator is dominant over the area. The presence of this shrub at once shows the soil to be of the non-draining sort, even with ditches present.

The herbarium, which will furnish a permanent record of the floristic composition, was begun.

A vegetational map (scale 1/80,000) was made based upon the hydrographic map of the area on which was placed from other maps, the drainage system and the section lines of the undrained portion, together with the principal roads of the region.

PLANT SUCCESSION

Succession Induced by Fire. The response of the vegetation following fire was especially interesting; much new data were secured bearing upon the significance of fire intensity as this factor through deep burning of the peat controlled the succeeding vegetation. The most prominent successional elements were *Solidago fistulosa*, *Erechtites hieracifolium*, *Andropogon Virginicus*, *A. glaucopsis*, and *Arundinaria arundinaria*.

No Successional Changes Following Drainage. In the five-year period following drainage no changes were noted in the undisturbed shrub complex along the ditches. Thus what has been called the lag effect of the bog habitat obtains here as well as in the grass-sedge bog.

Marginal or Transition Areas. These were studied and the communities were correlated with the bog proper. Especially interesting was the discovery of a grass-sedge bog occurring on mineral soil and forming a peninsula into the shrub-bog. This mineral soil relation confirms our previously made statement that shrub bog on peat, under fire, never goes into grass-sedge bog, while on mineral soil it does. The full explanation of this fact is still to be worked out.

At one point there is a transition to a gum swamp forest which will furnish a basis for valuable observations in the future.

A beginning was made in the establishment of permanent meter quadrats each marked by four galvanized iron stakes. The records made of each of these when compared with those made one or more years later will be invaluable in exactly demonstrating the changes now going on in the various major communities.

HABITAT ANALYSIS

In the time available only few data were obtained.

Rainfall (standard rain gauge used) was correlated with water depth in ditches during period of work. Notes were taken on hydroperiod on certain wells already established and in open undrained portion. These will prove valuable as a guide to further studies along this line.

NATURE AND ORIENTATION OF PEAT STRATA

Assistance was rendered Dr. Stokes in his work of taking soundings and making profiles at the various stations.

MICROCHEMICAL STUDIES

D. B. ANDERSON

This year was spent in Vienna, Austria, on leave of absence from N. C. State College. This time was spent in a study of microchemical methods, particularly with their application to the structure of plant cell walls.

Work was done upon the following subjects:

1. The structure of the collenchyma cell wall. The results of this study were published in the Sitzungsberichten der Akademie der Wissenschaften in Wien.

2. The chemical and physical structure of cotton fiber. A method for cutting very thin cross and longitudinal sections of cotton fibers was developed by Dr. Kisser and the writer. An account of this method was published in the American Journal of Botany 15: 437-441, 1928.

3. A study was made of the relationships of pectic materials and the hemicelluloses in plant cell walls with the aim of finding a method of removing one of these compounds without interfering with the other. This study was not completed, and consequently no account of it was published.

4. A study was made of the methods involved in the use of polarized light in the study of the submicroscopic structure of plant cell walls. This was work done in Zurich. In connection with this work a microchemical study was made of the epidermal cell wall of *Clivia nobilis*. This study made possible an explanation of the results of previous optical studies of the same cell wall. The results of this work were published in the Jahrbuch f. w. Bot. 49: 501-515.

5. A review of recent work on the structure of plant cell walls was written and is now in press.

6. A new microchemical reaction for determining the presence of reducing sugars in plant tissue was developed. This work is not yet complete and will be published as soon as the study has been finished.

THE MICROSCOPIC FLORA OF LAKE RALEIGH

L. A. WHITFORD

This work is nearing completion and will be presented at the end of the current year as a Masters Thesis.

Using this work as a basis, the project will be enlarged during the coming spring and summer to include others and different types of ponds. During the current winter certain common species are to be studied in culture.

SOIL MICROBIOLOGY

I. V. SHUNK

During the year 1927-28 I have been completing the experimental work on the project, "The Microbiology of the Soil of the Big Savannah, at Burgaw, N. C." A thesis covering this subject has been completed and is on file in the library of Rutgers University, at New Brunswick, N. J. A shorter article, including the more important parts of this work, will be prepared for publication during the winter.

B. W. WELLS,

Head, Department of Botany.

RESEARCH IN HORTICULTURE

The experimental work of the Department of Horticulture may be grouped conveniently according to crops, as tree fruits and nuts; small fruits, and vegetables. On these crops experimental methods applicable to a solution of problems arising from soil, adaptability or cultural conditions in North Carolina are applied. The relation of tree nutrition on winter killing of the peach, and the influence of pruning and fertilization on the food storage and subsequent yield of the dewberry are two Adams Fund projects bearing on practical phases of the culture of these crops that are being attacked.

Plant breeding methods are being applied to secure better quality, yield and adaptability of varieties of dewberries, raspberries, grapes, apples, pecans and of sweet potatoes and lettuce. Variety testing of fruits and vegetables which is closely associated with and often an integral part of a plant breeding study, is being given considerable attention. The value of this work has been demonstrated in the past by the origination of superior varieties of grapes and by introduction of better adapted and superior varieties of vegetables and fruits. The work will be continued that the Station may render further service of this nature.

Investigations dealing with growth and yield of the apple, peach, pecan, small fruits, and vegetables from the standpoint of cultural practices, such as rate of seeding, fertilization, fertilization and cover cropping, pruning and thinning, have already yielded valuable results that are being carried to and are being applied by the growers of the State. Such investigations conducted under North Carolina soil and climatic conditions are essential to intelligent, economical and profitable production.

Progress on the various projects being conducted by the various members of the staff is given.

PEACH INVESTIGATIONS

Winter Killing, C. F. WILLIAMS, *Leader*. An effort has been made to place the trees under different conditions of vegetative vigor and to determine their susceptibility to winter injury. A test winter has not occurred and relative injury has not as yet been determined. The death of a few trees in the plots could not be attributed to this cause.

The relative vigor of the trees under experiment is shown in the following table:

| Treatment | Average Increase in Trunk Diameter, Inches—1927-28 | Average Length Terminal Growth, May 15th, Inches—1928 |
|--|--|---|
| General practice..... | .27 | 1,308 |
| General practice plus 2 pounds nitrate, June 1st..... | .29 | 1,999 |
| General practice plus 2 pounds nitrate, June 1st, and again after harvest..... | .37 | 2,863 |

Differences in amount of terminal growth were greater earlier in the season. High nitrate plots developed foliage sooner and more rapidly than plots that had not received extra nitrogen the previous year. This would indicate that these trees went through the winter in better condition as regards reserve food material. This observation is correlated with data secured from laboratory analyses. However, these latter data are not at present complete, though significant differences have been secured in samples from trees in different plots.

A better set of fruit and greater yield occurred on plots receiving extra nitrate. This would not necessarily hold in such orchards already in good vegetative vigor.

As would be expected, trees that had been injured in years previous to the time the plots were laid out, are recovering more rapidly under additional treatment.

Pruning, M. E. GARDNER. This experiment at the Piedmont Branch Station, begun in 1923, is to determine the effect of heavy and light pruning on tree performance.

The lightly pruned trees have received very little pruning since the establishment of the framework of the tree. Only light thinning has been practiced and practically no heading has been done.

In the heavily pruned blocks, approximately fifty per cent of all new growth has been removed and some thinning done.

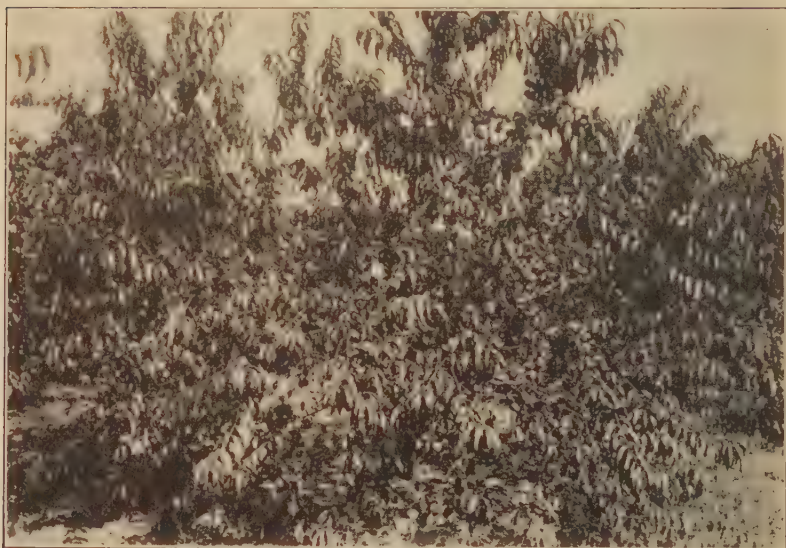
While the table does not indicate any very marked differences, the increased color, uniformity of fruit, marketability and reduced pruning cost, strongly favor the light pruning. Due to the dense foliage caused by heavy pruning, the color of the fruit is poor and insect and disease injury greater on the heavily pruned blocks. The bearing area is also restricted. Light pruning with thinning is to be recommended for the Piedmont section of the State.

The following table and the accompanying cuts give some comparisons:

| Variety | Average Yield per Tree—Bushels | | Average Trunk Diameter—Inches | | Average Weight Prunings Removed—Pounds | |
|--------------|--------------------------------|---------------|-------------------------------|---------------|--|---------------|
| | Light Pruning | Heavy Pruning | Light Pruning | Heavy Pruning | Light Pruning | Heavy Pruning |
| Hiley..... | 3.20 | 3.17 | 4.31 | 4.65 | 5.70 | 17.96 |
| Belle..... | 2.26 | 1.95 | 3.90 | 4.06 | 4.57 | 8.94 |
| Elberta..... | 2.05 | 2.00 | 4.01 | 3.98 | 2.63 | 8.69 |
| Hale..... | 2.55 | 2.20 | 3.86 | 4.24 | 3.51 | 11.03 |
| Augbert..... | 2.79 | 1.19 | 5.18 | 4.66 | 11.23 | 15.31 |

Fertilization, M. E. GARDNER. This experiment was designed and set out in 1923 at the Piedmont Station to determine the effect of quickly available nitrogen on yield under Piedmont conditions.

Fertilized trees have received an increasing amount of nitrate of soda each year since planting. The check or "No Nitrate" trees have not been fertilized.



Lightly pruned Georgia Belle. Note the open spreading habit of growth and the distribution of fruit.



Heavily pruned Georgia Belle. Dense foliage prevents high color and increases disease and insect injury. Bearing area also restricted.

Comparative results are shown in the following table:

| Variety | Average Yield per Tree, Bushels | |
|--------------|---------------------------------|------------|
| | Nitrate | No Nitrate |
| Augbert..... | 1.50 | .94 |
| Hale..... | 3.30 | 1.75 |
| Elberta..... | 3.43 | 1.65 |
| Belles..... | 2.00 | 2.50 |
| Hiley..... | 3.60 | 1.70 |

The "Nitrate" trees have maintained vigor and productiveness, while the "No Nitrate" trees have not. However, the unfertilized trees are not as low in vigor as might be expected, due to the high fertility of the Piedmont soil at the Branch Station.

DEWBERRY INVESTIGATIONS

Fertilizer Experiment, C. F. WILLIAMS, *Leader*. Fertilizer elements alone and in combination to determine the effect of the presence or absence of each have yielded negative results under Sandhill conditions. Applications were made four times a year. Single row plots were used with check rows between each treatment.

Unusual seasonal conditions doubtless masked the effects of the treatments as dewberry fields throughout the section were subnormal and often materially injured.

Pruning: Different systems and times of pruning have not yet yielded satisfactory or comparable results because of diseases. Cutting off all canes below the surface of the ground compared with cutting at or above the surface is apparently helpful in the control of cane blight or canker.

Physiological Studies: Samples from various parts of the plants grown under different conditions of nutrition have been collected and some analyses made. Results concerning this phase of the project are not ready for publication.

Variety Test: The Young dewberry fruited for the first time at Raleigh and shows great promise, at least as a home berry. The vine is vigorous and productive and not susceptible to disease. The fruit is large, sweet and of high quality, but seems to be rather soft for shipping.

Breedings: Seedlings of crosses of Young and Lucretia made in 1926 are growing at the Central Test Farm and should fruit in 1929. Crosses of Young with Gardena, Austin Thornless, and Young selfed failed. A few seed germinated, but seedlings were weak and died in the field.

The past season crosses were made with plants of Coreanus species type with Columbian, Latham, and Ranere raspberries. The Coreanus type is hardy in the southeast and resistant to various diseases. Crosses of Van Fleet with the same varieties of raspberries failed to set seed.

STRAWBERRY INVESTIGATIONS

Fertilizer Investigations, ROBERT SCHMIDT, *Leader*. This is a coöperative project at the Lower Coastal Plain Station with the Division of Agronomy. Results this year corresponded with those of last year in that the unlimed plots gave greater yields than the limed plots. The berries were smaller on the limed plots. Yields were not conclusive although the plots with nitrate of soda applications made high yields. In shipping tests that were made the fertilizer treatment apparently had no influence on the holding qualities of the berries in shipment.

Variety Test, M. E. GARDNER. A variety test of strawberries at the Mountain Station begun in 1925, has given good comparisons during the past year. These data are given in tabular form:

| Variety | *Season | | Vigor | Resistant to Disease | Yield per Acre (quarts) |
|---------------------|---------|------|----------------|------------------------|-------------------------|
| Warfield..... | 5/24 | 6/22 | Medium strong | Resistant | 7,576 |
| Premier..... | 5/24 | 6/20 | Strong | Resistant | 5,640 |
| Sample..... | 5/30 | 6/22 | Medium strong | Slight L. spot | 4,977 |
| Big Late..... | 5/30 | 6/20 | Medium strong | Slight L. spot | 4,479 |
| McAlpine..... | 5/30 | 6/22 | Strong | Leaf spot rather heavy | 4,258 |
| Big Joe..... | 5/28 | 6/20 | Medium | Resistant | 4,147 |
| S. L. Champion..... | 5/30 | 6/22 | Strong | Leaf spot rather heavy | 4,092 |
| Aroma..... | 5/28 | 6/20 | Medium..... | Resistant | 3,594 |
| Sen. Dunlap..... | 5/24 | 6/20 | Medium..... | Resistant | 3,373 |
| Chesapeake..... | 5/30 | 6/20 | Strong | Resistant | 3,097 |
| Missionary..... | 5/24 | 6/18 | Strong | Resistant | 3,041 |
| Gandy..... | 6/1 | 6/22 | Strong | Slight L. spot | 2,986 |
| Nich Ohmer..... | 5/28 | 6/20 | Weak to medium | Slight L. spot | 2,931 |
| Dr. Burrell..... | 5/28 | 6/18 | Weak | Resistant | 2,589 |
| Wm. Belt..... | 5/30 | 6/20 | Weak to medium | L. spot | 2,589 |
| Excelsior..... | 5/24 | 6/18 | Strong | Resistant | 2,378 |
| Klondike..... | 5/24 | 6/20 | Medium | Slight L. spot | 1,880 |

*Date of first and last pickings.

Warfield and Premier have given the highest acreage yields since the test was begun. Warfield averaged 4,202 and Premier 3,538 quarts per acre over a three-year period. Very low yields were recorded in 1926, due to excessively dry weather.

The plants have been trained according to the narrow matted row system, and recommended cultural and fertilizer practices followed.

Time of Fruit Bud Differentiation, G. O. RANDALL. Material has been collected during the last two years to determine the time of differentiation of flower primordia. The best methods of preservation, sectioning, and staining of this type of material have been worked out satisfactorily.

LETTUCE INVESTIGATIONS

Tip-burn Investigations, ROBERT SCHMIDT, *Leader*. The same treatments as those used last year were continued, with a few additions. One plot was covered with frames of Cel-O-Glass and the sides screened with cheese cloth in an endeavor to keep out all insects. The plants were dusted with pyrethrum and nicotine dust. The results were no different than where the plants were not screened or dusted.

Manganese sulphate was applied to the soil of two plots before planting at the rate of 50 pounds per acre. Tip-burn was very severe in these plots. Another plot was sprayed with manganese sulphate solution, with apparent detrimental results.

Selection: Of the 44 selections made in the field last year, three were selected for quality and size of head and apparent resistance to tip-burn. These will be planted next year for further test.

IRISH POTATO

Effect of Spacing on Yield of Irish Potatoes, ROBERT SCHMIDT, *Leader*. In this experiment rows were laid out $2\frac{1}{2}$, 3, $3\frac{1}{2}$ and 4 feet apart and the seed pieces were spaced 9, 12, 15 and 18 inches apart in the row for each width of row. All plots were fertilized with a 7-5-5 (P-N-K) fertilizer at the rate of 1,500 pounds per acre. In each case the 9-inch spacing gave high yields of No. 1 potatoes, but also gave a large yield of culls. The $2\frac{1}{2}$ ft. x 15 inches and $2\frac{1}{2}$ ft. x 18 inches plots also gave yields of No. 1 potatoes, but lower yields of culls.

Comparison of Cut Seed and Whole Seed Pieces, ROBERT SCHMIDT, *Leader*. The yield from whole seed pieces gave a 7-bushel per acre greater yield of No. 1 potatoes and an 8-bushel per acre greater yield of No. 2 potatoes than the cut seed pieces. A two-ounce seed piece was used. This difference in yield is not very conclusive, as it seems to change from year to year in favor of either the whole or cut seed piece.

Effect of Source of Seed on Field, ROBERT SCHMIDT, *Leader*. This season Irish Cobbler seed from Maine was compared with seed from South Dakota. The latter seed yielded 36 bushels more potatoes per acre than did Maine seed.

Storage of Spring Crop Irish Potatoes in Sweet Potato Storage House, ROBERT SCHMIDT, *Leader*. There was somewhat greater loss this year than in previous years. Possibly the potatoes were not so well hardened and matured.

Effect of Different Planting Distances on Yield, M. E. GARDNER. Data relative to the effect of different planting distances on yield of Irish Cobbler show that the closer planting gave the greater total yield and greater yield of No. 1 grade potatoes this season.

| Planting Distance | Plat Area | 2 Plot Yield—Bushels | | | | Yield per Acre—Bushels |
|-------------------|-----------|----------------------|-------|-------|-------|------------------------|
| | | No. 1 | No. 2 | Culls | Total | |
| 3' x 9"----- | 1 | 1.37 | 1.12 | 1.00 | 3.49 | 253.37 |
| | 72.6 | | | | | |
| 3' x 9"----- | 1 | 1.12 | 1.12 | 1.00 | 3.24 | 235.22 |
| | 72.6 | | | | | |
| 3' x 15"----- | 1 | 1.12 | .87 | 1.00 | 2.99 | 217.07 |
| | 72.6 | | | | | |
| 3' x 18"----- | 1 | 1.00 | 1.00 | .75 | 2.75 | 199.65 |
| | 72.6 | | | | | |

Two-ounce whole seed pieces used.

Both of these tests received the same fertilizer, cultural and spraying treatments, and all seed were treated with Bayer Dieldust.

Effect of the Size of the Seed Piece, M. E. GARDNER. A study at the Mountain Station to determine the effect of size of seed piece on yield of the white potato, Irish Cobbler gave the following results the past season:

| Size of Seed Piece (ounces) | Plat Area | Plot Yield—Bushels | | | | Total Yield per Acre—Bushels |
|-----------------------------|-----------|--------------------|-------|-------|-------|------------------------------|
| | | No. 1 | No. 2 | Culls | Total | |
| ½----- | 1 | .87 | .37 | .62 | 1.86 | 135.03 |
| | 72.6A | | | | | |
| 1----- | 1 | .75 | .75 | .75 | 2.25 | 163.35 |
| | 72.6A | | | | | |
| 1½----- | 1 | .87 | 1.00 | 1.00 | 2.87 | 208.36 |
| | 72.6A | | | | | |
| 2----- | 1 | 1.00 | 1.00 | .87 | 2.87 | 208.36 |
| | 72.6A | | | | | |
| 2 Cut----- | 1 | 1.00 | 1.00 | .87 | 2.87 | 208.36 |
| | 72.6A | | | | | |
| 2½----- | 1 | .87 | 1.00 | 1.00 | 2.87 | 208.36 |
| | 72.6A | | | | | |
| 3----- | 1 | 1.25 | 1.37 | 1.00 | 3.62 | 262.81 |
| | 72.6A | | | | | |
| 3½----- | 1 | 1.37 | 1.50 | 1.00 | 3.87 | 280.96 |
| | 72.6A | | | | | |

Planting Distance 3' x 15".

Whole seed pieces used except when noted.

These results indicate that under the seasonal and soil conditions of the past year, a 3 to 3½ ounce seed piece would give the greater yield.

SWEET POTATOES

Seed Selection and Strain Tests. ROBERT SCHMIDT, *Leader*. Until the year 1927 the improved strains of sweet potatoes which have been developed by the Department of Horticulture have not been tried out commercially. In 1927 two bushels of the best strain of selected Porto Rico seed stock were sent to the county agents of Brunswick and Chowan counties for trial. The results were outstanding. In Brunswick County a 20 per cent increase in yield over the common stock was obtained, and the potatoes were much smoother. In Chowan County a 35 per cent increase in yield in favor of the improved strain was recorded. These results are shown in Table No. 1.

TABLE No. 1. Comparison in yield between N. C. 14811 strain of Porto Rico seed with commercial stock. Plots were planted June 20, 1927, and harvested October 27, 1929, Edenton, N. C.

| Plat | Area | Yield—Pounds | | | Yield per Acre—Bushels | | | Total Yield per Acre* Bushels |
|---------------------------|------|--------------|-------|-------|------------------------|-------|-------|-------------------------------|
| | | No. 1 | Jumbo | Culls | No. 1 | Jumbo | Culls | |
| Strain 14811..... | 1 | 348.5 | 62.5 | 53.5 | 248.9 | 44.6 | 38.2 | 331.7 |
| Check—Ordinary stock..... | 40 A | 231.5 | 35.5 | 75.0 | 165.4 | 25.4 | 53.7 | 244.5 |

*56 pounds = 1 bushel.

Effect of Planting Distance on Yield of Sweet Potatoes. In previous years the planting distances used were 12 inches, 18 inches and 24 inches. The past year the 24-inch distance was discontinued and 8 and 10-inch distances were added. Results as shown in Table No. 2 indicate that spacing closer than 12 inches gives no appreciable increase in yield of marketable potatoes.

TABLE No. 2. Effect of planting distance on yield of Porto Rico sweet potato. Planted June 1, 1927, harvested October 18, 1927, Lower Coastal Plain Station, Willard, N. C.

| Plat | Area | Yield—Pounds | | | Yield per Acre—Bushels | | | Total Yield per Acre* Bushels |
|--------------------------|------|--------------|-------|-------|------------------------|-------|-------|-------------------------------|
| | | No. 1 | Jumbo | Culls | No. 1 | Jumbo | Culls | |
| Plants 8-in. apart..... | 1 | 176.5 | 28.5 | 22.0 | 188.1 | 30.5 | 23.6 | 242.2 |
| Plants 10-in. apart..... | 60 A | 175.0 | 30.0 | 23.0 | 187.5 | 32.2 | 24.7 | 244.4 |
| Plants 12-in. apart..... | 1 | 182.0 | 17.0 | 21.0 | 195.0 | 18.2 | 22.5 | 235.7 |
| Plants 18-in. apart..... | 60 A | 158.5 | 45.5 | 9.0 | 169.8 | 48.8 | 9.7 | 228.3 |

Rows 3½ feet apart.

*56 pounds = bushel.

Sweet Potato Fertilizer Test. The object of this experiment is primarily to show the effect of varying amounts of potash on the yield of sweet potatoes and also to compare animal and mineral sources of nitrogen in sweet potato fertilizers.

Contrary to results of previous years, fertilizers containing a high percentage of potash did not give higher yields this year. However, nitrogen derived solely from mineral nitrates gave a substantial increase in yield over the nitrogen derived from animal sources. These results are shown in Table No. 3. All fertilizer was applied in the ridge before setting the plants.

TABLE NO. 3. Effect of different fertilizers on the yield of sweet potatoes, Porto Rico variety. Potatoes planted June 1, 1927, harvested October 17, 1927, at Lower Coastal Plain Station:

| Plat | Area | Yield—Pounds | | | Yield per Acre—Bushels | | | Total Yield per Acre* Bushels |
|-----------------------------|------|--------------|-------|-------|------------------------|-------|-------|-------------------------------|
| | | No. 1 | Jumbo | Culls | No. 1 | Jumbo | Culls | |
| 8-3-6 Nitrate of soda----- | 1 | 804.5 | 126.0 | 39.0 | 287.3 | 45.0 | 13.9 | 346.2 |
| | 20A | | | | | | | |
| 8-3-6 Tankage-- | 1 | 700.5 | 120.0 | 37.5 | 250.2 | 42.9 | 13.4 | 206.5 |
| | 20 A | | | | | | | |
| 8-3-6 Sulphate of ammonia-- | 1 | 782.5 | 107.5 | 41.5 | 279.5 | 38.4 | 14.8 | 332.7 |
| | 20 A | | | | | | | |

Effect of Maturity, Frost and Time of Digging on the Keeping Quality of Sweet Potatoes. This experiment is being carried on at both Coastal Plain Stations, and the results correspond very closely. Potatoes dug early, that is, while immature, will keep practically as well as potatoes dug later in the season when well matured, if all are properly cured. On the other hand, if sweet potatoes are left in the ground until a few days after a hard frost has killed the vines, a heavy loss may be expected.

TABLE NO. 4. Effect of Maturity, Frost and Time of Digging on the Keeping Quality of Sweet Potatoes, Porto Rico Variety, at the Upper Coastal Plain Station, Rocky Mount, N. C.:

| Date Harvested | Date Taken from Storage | Number of Crates | Total Number of Potatoes | Number Sound | Number Decayed | Per Cent Loss Decay | Per Cent Loss of Weight |
|----------------|-------------------------|------------------|--------------------------|--------------|----------------|---------------------|-------------------------|
| 9-28-27 | 3-22-28 | 4 | 320 | 317 | 3 | .94 | 11.94 |
| 10-10-27 | 3-22-28 | 4 | 270 | 261 | 9 | 3.33 | 13.95 |
| 10-24-27 | 3-22-28 | 4 | 356 | 352 | 4 | 1.12 | 12.79 |
| 11-17-27 | 3-22-28 | 4 | 299 | 269 | 30 | 10.03 | 17.01 |

PECAN INVESTIGATIONS

Pecan Breeding. ROBERT SCHMIDT, *Leader*. In 1927 about 80 trees in the seedling block produced nuts. Of these 75 per cent were pronounced of poor size and quality, and these trees have been removed. A few trees produced nuts which appear promising and have been retained.

Variety Tests with Pecans. Thirty-two of the most important southern varieties are included in this project. 1927 was the twenty-first year since planting the groves at the Lower and Upper Coastal Plain Branch Stations. Most of the varieties produced good yields this year, one Stuart tree producing more than 125 pounds of nuts.

Cracking Tests with Pecans. The cracking test of each variety of pecans grown in the experimental orchards was made as in previous years. The Schley variety continues to hold the lead in cracking quality.

Orchard Management in Relation to Annual and Alternate Bearing of Pecans. This is a new project and no results have been obtained. Three blocks have been laid out in the pecan grove at the Upper Coastal Plain Branch Station. The first block receives clean cultivation with no cover crop, the second receives clean cultivation with a cover crop of rye and vetch, and the third receives sod culture.

APPLE INVESTIGATIONS

Summer Apples. ROBERT SCHMIDT, *Leader*. A block of summer apples at the Coastal Plain Branch Station produced a light crop this year. Only one tree of the Yellow Transparent variety is left, the others having been killed out by blight. Williams Early Red, Red Astrachan, Eckels Sweet Red June, Liveland Raspberry, and Delicious have shown up best from both the standpoint of yield and vigor of the tree.

Pruning and Training. M. E. GARDNER, *Leader*. This project was begun in 1919 at the Mountain Station in order:

(1) To determine the effect of the amount of annual pruning on earliness of bearing and productiveness.

(2) To contrast the open center and modified leader methods of training, and the comparative value of low and high headed trees.

Light thinning with no heading back of branches has been practiced in the lightly pruned block. Moderate thinning has been practiced in the moderately pruned blocks, and heavy thinning with some heading in the heavily pruned blocks.

Table No. 1 gives the results as to yield and Table No. 2 the circumference measurements.

Fifty-two trees in the experiment were headed at twenty-four inches when planted, and trained according to the open head system. Fifty-six trees were headed at thirty-six inches and trained according to the modified leader system. Present indications give preference to the trees headed at thirty-six inches and trained according to the modified leader system.



Growth response of a Winesap tree to light pruning. Larger yields, better colored fruit and less injury from insects and disease.



A Winesap tree heavily pruned. Smaller yields, poorer color and more injury from insects and diseases, particularly aphids and scab.

TABLE No. 1. Yield Response of Varieties to the Different Pruning Treatments:

| Variety | Age | Heavy Pruning | | Medium Pruning | | Light Pruning | |
|-----------|-----|---------------|-----------------------|----------------|-----------------------|---------------|-----------------------|
| | | No. Trees | Average Yield—Bushels | No. Trees | Average Yield—Bushels | No. Trees | Average Yield—Bushels |
| Delicious | 9 | 11 | 1.90 | 8 | 3.89 | 8 | 7.06 |
| Stayman | 9 | 11 | 2.70 | 8 | 4.95 | 8 | 5.34 |
| Winesap | 9 | 11 | 1.30 | 8 | 1.73 | 8 | 2.29 |
| Rome | 9 | 11 | .94 | 8 | 1.00 | 8 | 2.10 |

TABLE No. 2. Growth Response of Varieties to the Different Pruning Treatments:

| Variety | Age | Heavy Pruning | | Medium Pruning | | Light Pruning | |
|-----------|-----|---------------|-----------------------|----------------|-----------------------|---------------|-----------------------|
| | | No. Trees | Average Circumference | No. Trees | Average Circumference | No. Trees | Average Circumference |
| Delicious | 9 | 11 | 15.82 | 11 | 16.34 | 11 | 17.22 |
| Stayman | 9 | 11 | 18.04 | 11 | 19.31 | 11 | 18.62 |
| Winesap | 9 | 11 | 16.27 | 11 | 19.15 | 11 | 19.72 |
| Rome | 9 | 10 | 13.46 | 11 | 16.44 | 10 | 15.25 |

Table No. 3 is inserted below to give some idea of the weight per tree of the prunings removed and the present condition of the trees under each treatment. The pruning will vary somewhat from year to year, but the table is indicative of the severity of the treatment.

TABLE No. 3. Pounds of Prunings Removed Per Tree:

| Variety | Average Weight of Prunings Removed | | |
|-----------|------------------------------------|------------|------------|
| | Heavy | Medium | Light |
| Delicious | 27.82 lbs. | 15.25 lbs. | 6.87 lbs. |
| Stayman | 34.00 lbs. | 17.37 lbs. | 10.75 lbs. |
| Winesap | 35.79 lbs. | 15.75 lbs. | 11.50 lbs. |
| Rome | 16.00 lbs. | 9.62 lbs. | .07 lbs. |

Fertilization. M. E. GARDNER. In 1924, trees were set out at the Mountain Branch Station to determine the effect of different fertilizer elements alone and in combination on growth and production.

One hundred and sixteen trees of the Delicious and Bonum varieties are used in this experiment. The planting is divided into fifteen plots, each receiving a different treatment.

Certain tendencies as to growth are indicated, but no results are reported this year on either growth or yield as the trees have borne only a few scattered fruits.

J. H. BEAUMONT.

Head, Department of Horticulture.

RESEARCH IN POULTRY

INFLUENCE OF MEAT MEAL VS. MILK IN CHICK DEVELOPMENT

On this test of S. C. Rhode Island Red chicks, one flock received meat meal as the sole source of animal feed, and the second, milk.

The chicks of the milk lots grew off rapidly and had a more vigorous appearance with very few underdeveloped chicks. At six weeks of age the difference was marked. There was a loss of only 9 from a brood of 216 chicks receiving milk, while in the brood receiving meat meal 38 out of 184 died.

During the first four weeks there was a death rate of 11.4 per cent in the milk lot, and 20.6 per cent in the meat meal lot. In the second week there was a loss of 11.8 per cent in the milk lot, and 10.2 per cent in the meat meal lot. Both lots of chicks were reared under electric brooders.

The cost of putting pullets into lay, using milk in one flock and meat meal in the other, is still in progress.

Milk has a tendency to push the pullets into early egg production and to increase the weight of the bird, but it also shortens their lives. In studying the mortality statistics it is observed that mortality is highest in the very fat hens.

Cod liver oil with milk in the ration makes less difference in the color of S. C. Rhode Island Reds than cod liver oil with meat meal in the ration, or than milk or meat meal used alone.

COMMERCIAL UNIT PLANT MANAGEMENT

In these studies it is to be determined the best methods of management for a commercial plant. Many angles are under observation. Poultry work in broiler production, pullet production, fattening, and egg production can by right management be made profitable in North Carolina.

During the year just closing four flocks were tested on the cost of putting pullets into lay. The feed cost runs from sixty cents to seventy-five cents. The test was run on S. C. Rhode Island Reds. The pullets came into lay at the age of about five months, or a few days before this time.

BLACKHEAD STUDIES

A survey has been made in Jackson, Madison, Ashe and Avery counties to determine the extent of blackhead and to lay plans for coöperative work with the mountain farmers in an effort toward aiding them to successfully rear their turkeys.

This survey showed that less than fifty per cent of the poults were reared this year. The year was wet and rainy, but it is quite evident that better methods are badly needed. In many cases the turkey hen leaves the farm yard and takes her brood into the mountains and does not come down until fall when feed becomes scarce. Then the old ones return bringing the poults that have grown well on to maturity. This plan is to work with better methods of housing the young from storm, and better means of feeding in an effort to

avoid and control disease. Twenty farmers are coöperating in the work. It was found that the game law protected the fox and that this animal was causing great loss among the turkeys and poultry.

VITAMIN EXPERIMENTS

Experiments to determine the economic sources of fat soluble vitamin have been continued. Work is being conducted at this time to determine the length of time mash can be mixed and stored and yet retain an efficient supply of vitamins, both fat soluble A and D.

It was shown that cod liver oil increases fertility and hatchability.

In vitamin studies at the Coastal Plain Branch Station the vitamin supplement in the form of cod liver oil was more marked in its stimulative effects on health and development on the flock fed meat meal than on the milk-fed flock.

It was shown that mineral supplements of calcium, sodium, chlorine, phosphate, iron and iodine, with vitamin supplement as furnished by cod liver oil, gradually improve the health of a flock as measured by production, mortality, condition of plumage, fertility, hatchability and resistance to disease.

Observations during the past winter show that white mangles do not contain fat soluble vitamins. A mash containing dried orange peel and pulp as a source of vitamins was used on 400 S. C. White Leghorn hens, and the same mash without the vitamin supplement on 400 controls. Green feed was also given until the middle of January. When the green feed was discontinued and a like amount of mangles substituted, the hens on orange pulp vitamin supplement continued their speed of production, while a slump of 20 eggs per day, or 5 per cent, was noted in the pen not receiving this supplement.

STUDY OF CONTAGIOUS DISEASES OF CHICKS

This study is still in progress. So-called brooder pneumonia has been shown to be bacillary white diarrhea, this disease showing infective focal areas of the lungs with pus formation.

Coccidiosis is most prevalent among range chicks of about one pound weight. Experiments in an effort to control the disease with sanitary measures, together with buttermilk or soured skimmed milk and sulpho-phenol bichloride, has been very successful. *

Muco-enteritis is on the increase and affects especially the young range and laying birds.

FATTENING POULTRY

Experiments in fattening poultry are being continued. There has been developed a new method of keeping the fattening birds cool during the hot weather. It was observed that excessive heat interfered with fattening, throwing them off feed. The chicks on a milk ration would go off feed sooner than those on a meat meal ration. An umbrella shelter was constructed under a large pecan tree. This furnished shelter from rain and sunshine. During winter months a shed or house is required to keep the birds warm. A simple ration of equal parts corn meal and pulverized oats gave best results when used in the proportions of one pound mash mixture to two pounds milk or twenty per cent meat meal. The feed is given three times a day and just what they will clean up in thirty minutes. The troughs are then removed.

POULTRY DISEASE INVESTIGATIONS

R. S. DEARSTYNE

There are two major projects in poultry disease under investigation at the present time on which the following progress report is submitted:

Avian Typhoid. On this study investigations of the immunological aspects are being carried out with the following results from July 1 to date:

The immunity produced by the single dose method of vaccination using 1 cc. vaccine has been studied on two groups of 21 birds each. In Group 1 commercial polyvalent vaccine was used, and in Group 2 a vaccine developed in the Disease Research laboratory was used. The general results indicate that the gross immunity established is of about equal degree. Antibodies which will agglutinate on antigen in a dilution of 1:100 are present in 24 hours. This is increased until at 72 hours after vaccination the antibody content is at its peak of concentration, agglutinating an antigen in a dilution of 1:200. Studies are being conducted as to the duration of this immunity.

This work was substantiated by artificial infection of vaccinated birds, the first of this series showing that in vaccinated birds infected one, two and three days after vaccination the control bird and bird infected 24 hours after vaccination died eight days after infection. The bird infected 48 hours after vaccination died ten days after infection, and the bird infected 72 hours after vaccination showed a slight attack of the disease, but the immunity established was sufficient to throw off the disease and the bird is living to date, 18 days after infection.



Umbrella type shelter located under a pecan tree to protect fattening crates during hot weather and insuring comfort to the fattening birds.

This first series confirms the immunity studies noted heretofore and is the first of a series of infection experiments of the dosage of vaccine necessary to produce a safe immunity in a single vaccination, the above experiment being on a minimum quantity.

At the Disease Plant there are three series of birds vaccinated with the single, double and triple method. This is to determine the efficiency of such methods and the birds are to be held over a long time period for determining the duration of immunity produced by such methods of vaccination. This is carried on with the commercial polyvalent vaccine and the vaccine produced in the disease laboratory, there being 14 birds in each series.

Bacillary White Diarrhea. This project includes a study of the intermittent reactors to the macroscopic agglutination test for bacillary white diarrhea. Examination of the records of the State Veterinarian's office show that out of 11,195 birds tested twice, 758 of 6.8 per cent reacted on the second test after being negative on the first. There is a basis for strong suspicion that the great majority of these birds were not intermittent reactors, but were infected by ranging on ground which has been occupied by chicks suffering from the septicemic form of the disease.

Tests run every fourteen days on the Station's infected flock for a period of eleven months reveal a great fluctuation of antibody content in the serum of the carrier birds, there being 12 of the 24 birds studied which could be classified as true intermittent reactors. The eggs from these birds have been analyzed and a large per cent incubated, and the studies carried into the first generation. The egg infection ratio from the infected flock is as follows:

| 1928 | Eggs | Infected | Per Cent |
|---------------|------|----------|----------|
| January..... | 74 | 3 | 4.1 |
| February..... | 155 | 5 | 3.2 |
| *March..... | 357 | 7 | 2.0 |
| *April..... | 108 | 11 | 10.2 |
| *May..... | 449 | 30 | 6.7 |
| June..... | 388 | 29 | 7.5 |
| July..... | 305 | 19 | 6.2 |
| August..... | 299 | 50 | 16.7 |

*Some eggs used for hatching.

The following data were secured from hatching eggs from flock:

| | |
|--|--------------|
| No. eggs started | 1,019 |
| Broken or discarded..... | 27 |
| Infertile | 112 |
| Per cent infertility..... | 87.6 |
| Dead embryos 21st day..... | 587 |
| Hatched | 293 |
| Per cent hatchability of fertile eggs..... | 32.3 |
| S. Pullora (organism of bacillary white diarrhea) recovered from eggs not hatched..... | 122 |
| Chick mortality to September 1..... | 168 |
| Per cent of hatch..... | 57.4 |
| Instances of recovery of germ..... | 113 or 67.9% |

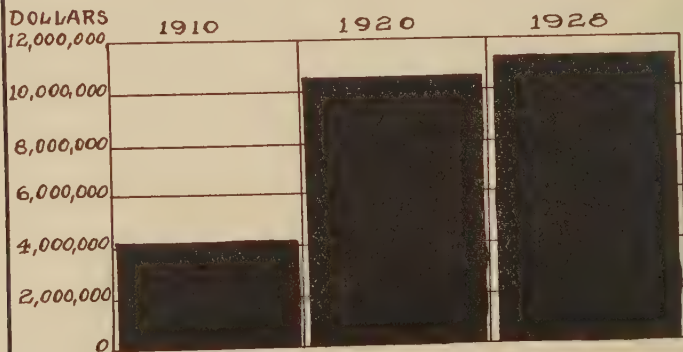
Studies of Chicks Hatched. Studies of chicks hatched show that in fifty to sixty days after hatching 14 out of every 24 chicks show antibodies

NORTH CAROLINA

VALUE FOWLS ON FARMS



VALUE EGGS PRODUCED



against disease. In 60 to 70 days 6 out of 12 show antibodies; in 70 to 80 days, 5 out of 6; and from 80 to 90 days, 7 out of 12. Of these 54 birds which were autopsied four showed lesions of the disease and the organism was recovered from 12 of them. From the data secured it will be possible to accurately trace the course of the disease from the septicemic form as it occurs in chicks, to the carrier form in adults. This information heretofore has been unavailable.

Of the hatched saved for further study, 16 out of 24 birds were positive to the agglutination test in 110 days after hatch. These birds are being tested each 30 days and the eggs are analyzed.

BACTERIOPHAGE

H. S. WILFONG

Fourteen strains of the bacteriophage active against the causative organism of avian typhoid have been isolated and studied in regard to some of their properties.

Eight of these strains were isolated from the fecal material of birds under study. The bacteriophage isolated had a virulence ranging from 1 + to 3 +.

Six strains were isolated from fecal material from various farms where avian typhoid had occurred.

Eight cases of avian typhoid have been studied in which the bacteriophage was used as a prophylactic agent, and six birds are now under observation.

HATCHING EXPERIMENTS

W. F. ARMSTRONG

Over a three-year period 29,010 eggs of all the popular breeds were set with a hatch of 20,320 chicks, or 70 per cent of all eggs set. This quantity is sufficient to insure a safe estimate upon which a poultryman may base his hatches. The per cent hatch with various breeds would depend largely upon individual flocks where only a few hundred eggs were set, therefore, a continuation of the experiment will bring out the hatching expectancy of various breeds when more flocks of the same breed are used. So far White Leghorns are leading all other breeds and varieties by four per cent.

Kerosene consumption shows a decided correlation with room temperature.

The turning of eggs 3 and 5 times a day during incubation has not been carried long enough to draw conclusions due to the arrangements of those sections in the incubators for one season. The next season's totals will no doubt equal the conditions for the two seasons and bring out better results in favor of turning five times. For the first season turning five times shows a .2 per cent better hatch.

S. C. Rhode Island Reds and White Leghorns were about equal in fertility and better than other breeds.

The greater per cent hatches were from February 20 to March 26. Fertility apparently declines late in the season.

Sale of baby chicks shows twice the profit over custom hatching. The sale of chicks requires a much larger operating capital.

B. W. KAUPP,

Head, Poultry Department.

RESEARCH IN ZOOLOGY AND ENTOMOLOGY

On the whole, the research work in this department has progressed very satisfactorily the past year. Our chief handicap has been that we have not had the necessary force to carry on the work in the field.

Biology of the Leaf Hopper, Z. P. METCALF, *Leader*. Very little time was devoted to this project during the past year, except to a study of the morphology and systematics. This is due to the fact that the leader of the project has only a very limited time to spend in the field. Smith College is prepared to publish the results of one phase of this study, which has been carried on for twenty years, in their catalog of the Hemiptera of the World, provided we can get the material in shape for publication.

The pecan spittle insect was found causing serious injury to pecans near Wilmington. Twelve materials were tried as contact insecticides. Nicotine sulphate 1 part to 400, and calcium cyanide "A" dust both gave effective control. The latter caused a slight amount of foliage injury.

The Corn Root Worm. The rotation experiments for the control of the corn root worm were continued at the Pender Branch Station. The first planting and the replanting were so badly damaged by corn bill bugs that no conclusions could be drawn. A thorough study of the life history was made during the summer, and the indications are that these studies will lead to better methods of control. The fact that the eggs from the overwintering adults are laid early in the spring would seem to indicate that winter plowing and fallow cultivation might be satisfactory. This method will be tried out this season.

Corn Ear Worm, B. B. FULTON, *Leader*. Some experiments on the hibernation of the pupæ have been started, and a thorough study of methods of control for this important insect is to be made.

The Human Blood Groups, L. H. SNYDER, *Leader*. The remaining outstanding problem in the field of human blood groups is their relation to other human blood characters, especially disease and disease susceptibility. During the past year extensive data on this subject has been secured and will be analyzed during the coming year. Blood samples have been taken from some 20,000 persons, with complete clinical data of each individual. The blood group work is being put into book form at the request of the Williams and Wilkins Company, publishers.

Next year this project could be merged with project No. 22, "Human Inheritance."

Wintering of Bees, F. B. MEACHAM, *Leader*. This project has been continued for several years, and much valuable data have been collected and assembled. It seems well worth while to continue this work, due to material variations in different seasons, and information on the average is important. Much interest has been shown in this work by the beekeepers over the State. Most of the investigation along this line has been done with a small number of colonies, on an average small apiary.

During the past season twenty colonies were included in the experiment representing colonies in different conditions. In the fall the bees were weighed and the number in each hive estimated. The brood was counted and the food supply carefully checked, other data and notes were also secured.

At the close of the winter period like data was secured and from this we are able to obtain valuable information, both in a practical and scientific way, concerning wintering of bees in North Carolina.

A Survey of the Honey Producing Plants of the State, F. B. MEACHAM, *Leader*. This is a continued project because the blooming dates of plants vary, due to the changeable seasons. In this project the data for each year is used to secure average results, and the greater the number of years, the more important the average.

About two hundred and fifty blanks were mailed to beekeepers located over the State. These blanks were to be filled in with the names of honey plants and their blooming dates. Their importance as a honey yielder and some other remarks were requested. These reports should be ready now and preparations for their collection are going forward.

Several valuable records have been returned since last report, and soon material enough should be available for a paper.

The Bees of North Carolina, T. B. MITCHELL, *Leader*. During the past year several species of bees either new to the State, or of rare occurrence, have been recorded, and considerable data have been obtained with reference to the distribution of bees over the State. Emphasis is still being laid upon records of flowers which bees visit and pollinate. These records are not only of value in indicating the species of bees that are of importance in pollination, but they also give valuable ecological data, since the distribution of the flowering plants is an important limiting factor in the distribution of their insect visitors, both in space and in time.

A Survey of Animals of the State, Z. P. METCALF, *Leader*. This project should be continued, as we are constantly accumulating information of value.

Anatomy and Physiology of the Rat, Z. P. METCALF, *Leader*. This project has been actively pursued during the past year. Careful studies have been made of the digestive, reproductive, and circulatory system of the rat. The report on this project will be published as a textbook this spring.

The Inheritance of Habits, with Especial Reference to Mental Traits, L. H. SNYDER, *Leader*. This project was not actively attacked during the past year, due to lack of time, but should be continued, as it is hoped to get at it this year.

Multiple Factors in Invertebrates, L. H. SNYDER, *Leader*. Further search has been made for material which will help to solve this problem. Measurements have been made on new forms, but no ideal material has yet been found. Further work will be done during the coming year.

Modification of the Germ Plasm, L. H. SNYDER, *Leader*. A start was made on this project, but it is a long time proposition and must be continued.

The Taxonomy and Biology of the Leaf-cutter Bees, T. B. MITCHELL, *Leader*. One paper concerning abnormalities of sex found to occur in the leaf-cutter bees (*genus Megachile*) has been written and is now in the hands

of a publisher. Abnormal individuals of thirteen species were discovered, and these have been described in this paper and their possible causes discussed. This is of importance through its bearing upon the question of sex determination.

A large amount of material from all parts of North America has been procured from various collectors and institutions, and this has been identified and many species new to science discovered. These new species have been described in manuscript, and these will be published in a monograph of this genus in North America, which is now being prepared.

The Economic Importance of Some North Carolina Birds, L. H. SNYDER, *Leader*. The returns from banded quail are coming in slowly. Observations have been made on food habits of some of our birds, particularly the starling and bobolink. A bulletin of the birds of the State has been prepared and has been distributed.

Studies in Human Inheritance, L. H. SNYDER, *Leader*. From time to time the opportunity arises to study the inheritance and linkage relations of various human characters. This opportunity should be grasped.

The Technique of blood grouping, *Southern Med. and Surg.*, 1928, 90: 584-585.

The blood groups in medicine, *Southern Med. and Surg.*, 1928, 90: 630-631.

The blood groups of the Jamaicans, *Carnegie Inst., Wash., Special Publication*, 1928.

Crickets, B. B. FULTON, *Leader*. The life histories of two crickets of economic importance have been studied. Physiological varieties have been found in three other species of crickets.

Harlequin Bug, B. B. FULTON, *Leader*. A large number of laboratory tests were made on the harlequin bugs using every kind of material available that might have value as a contact insecticide. A technique was worked out to insure uniform results in the experiments. Insecticidal soaps gave the best results at first, but it was later found that many of the common laundry soaps killed even better than the insecticidal soaps. Some irregularity in results proved later to be due to variations in atmospheric evaporation following spraying. Under conditions of high evaporation a 2 per cent soap spray is less effective than a one-half per cent in a saturated atmosphere. Spraying in the field on bright, dry days gave poor results, but during humid weather the effectiveness was limited only by the cover protection afforded by the plants.

Z. P. METCALF,

Head, Department of Zoology and Entomology.

RESEARCH IN RURAL SOCIOLOGY

A STUDY OF RURAL COMMUNITY ORGANIZATIONS IN NORTH CAROLINA

Proposed Steps in the Project:

- (a) A preliminary study, by way of a questionnaire, sent to all counties in order to get a survey of the community organizations in the State.
- (b) A detailed analysis of a certain selected number of community organizations, including:
 1. A census of the population, ethnic, farm tenure, etc., in the counties where the organizations were found.
 2. A study of the past history of community organizations.
 3. A detailed study of the present membership.
 4. A case study of all the leaders in the organizations.
 5. A structural analysis of the organizations, constitution, by-laws, etc.
 6. A program and project analysis.
- (c) Gathering the field data on schedules prepared to include the above.
- (d) Tabulate the data.
- (e) An analysis or interpretation of the findings.

PROGRESS REPORT TO NOVEMBER 1, 1928

- (a) The preliminary questionnaire analysis complete.
- (b) (1) The census analysis of the population, ethnic, character, etc., not yet begun.
 - (2) Records gathered on one hundred and sixty (160) community organizations in seven typical North Carolina counties.
 - (3) Membership data completely gathered.
 - (4) Leadership data already gathered.
 - (5) Structural analysis of organizations already gathered.
 - (6) The data for a general analysis of the program already gathered and the beginning made on having each organization keep a six months detailed record on programs and projects just being started.
- (c) The assistants have practically completed the field work.
- (d) The data are now being tabulated, those for one county being complete.

Prof. W. A. Anderson's study of "Living Conditions Among White Land-owner Operators in Wake County" has come from the press as Experiment Station Bulletin No. 258. It is a detailed analysis of the facts concerning the total income and expenditures of 294 typical white land-owning and farm-operating families. It is not primarily an economic analysis for the final measurement of the farm operations and conditions or the standard of living or level of living of the farm families. The emphasis is, therefore, on consumption practices with income practices as a necessary and primary conditioning factor.

The second study of "Living Conditions Among White Tenant-operators in Wake County" is now being prepared with the following work completed:

1. All field work done.
2. All data tabulated.
3. Tables three-fourths complete.

This manuscript to be complete early in July, 1929.

CARL C. TAYLOR,
Head, Department of Rural Sociology.

FINANCIAL STATEMENT

The following is a certified statement of the receipts from the Treasurer of the United States, supplementary funds from the State Department of Agriculture and sales from the Station farms with a record of their disbursement:

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
In account with the UNITED STATES APPROPRIATION, 1927-1928.

Dr.

| | <i>Hatch Fund</i> | <i>Adams Fund</i> | <i>Purnell Fund</i> |
|--|-----------------------|-----------------------|-------------------------|
| To receipts from the Treasurer of the United States, as per appropriation for the fiscal year ended June 30, 1928, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund), and February 24, 1925 (Purnell Fund) ----- | \$15,000.00 | \$15,000.00 | \$20,000.00 |

Cr.

| | | | |
|--|-------------------|-------------------|-------------------|
| Salaries ----- | \$12,213.00 | \$11,920.00 | \$23,011.47 |
| Labor ----- | 205.98 | 293.66 | 2,724.02 |
| Stationery and office supplies ----- | 167.22 | 34.45 | 177.74 |
| Scientific supplies, consumable ----- | 38.16 | 508.47 | 581.03 |
| Feeding stuffs ----- | | 133.98 | 3,961.60 |
| Sundry supplies ----- | 101.21 | 86.49 | 689.51 |
| Fertilizers ----- | | 4.50 | 113.00 |
| Communication service ----- | 46.55 | 24.86 | 26.83 |
| Travel expenses ----- | 1,441.17 | 944.32 | 3,012.01 |
| Transportation of things ----- | 35.00 | 200.27 | 181.84 |
| Publications ----- | 379.18 | | 413.28 |
| Heat, light, water and power ----- | 1.14 | 38.60 | 64.77 |
| Furniture, furnishings, fixtures ----- | 292.69 | | 53.45 |
| Scientific equipment ----- | | 800.06 | 852.65 |
| Livestock ----- | | | 2,277.05 |
| Tools, machinery and appliances ----- | 78.70 | 10.34 | 341.09 |
| Buildings and land ----- | | | 1,518.66 |
| Contingent expenses ----- | | | |
| | <hr/> \$15,000.00 | <hr/> \$15,000.00 | <hr/> \$40,000.00 |

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
In account with FARM AND MISCELLANEOUS RECEIPTS.

Dr.

| | |
|--------------------------------------|-------------|
| State Department of Agriculture..... | \$60,000.00 |
| Sales | 8,517.11 |
| Miscellaneous Receipts | 5,756.16 |
| Total..... | \$74,273.27 |

Cr.

| | |
|---|-------------|
| Salaries | \$41,386.85 |
| Labor | 5,729.03 |
| Stationery and office supplies..... | 604.38 |
| Scientific supplies, consumable..... | 460.87 |
| Feeding stuffs | 3,562.36 |
| Sundry supplies | 1,454.65 |
| Fertilizers | 1,450.07 |
| Communication service | 751.71 |
| Travel expenses | 7,153.48 |
| Transportation of things..... | 311.43 |
| Publications | 534.21 |
| Heat, light, water and power..... | 576.47 |
| Furniture, furnishings and fixtures | 995.12 |
| Library | 276.57 |
| Scientific equipment | 720.24 |
| Livestock | 271.35 |
| Tools, machinery and appliances..... | 936.72 |
| Buildings and land | 659.57 |
| Contingent expenses | 3,097.48 |
| Unexpended balance | 2,376.71 |
| Total..... | \$74,273.27 |

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the North Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1928; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was *nothing* on the Hatch Fund, *nothing* on the Adams Fund, and *nothing* on the Purnell Fund; that the receipts for the year from the Treasurer of the United States were \$15,000.00 under the act of Congress of March 2, 1887; \$15,000.00 under the act of Congress of March 16, 1906, and \$40,000.00 under the act of Congress of February 24, 1925, and the corresponding disbursements \$15,000.00, \$15,000.00, and \$40,000.00, for all of which proper vouchers are on file and have been by us examined and found correct, leaving balances of *nothing*, *nothing*, and *nothing*, respectively.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, March 16, 1906, and February 24, 1925, and in accordance with the terms of said acts, respectively.

(Signed) W. T. DIXON,
A. H. HOWELL,
Auditors.

(Seal)

Attest:

A. F. BOWEN,
Custodian of the Seal.

